

Twelve weeks of interval training with elastic resistance increases aerobic fitness: case report

Doze semanas de treinamento intervalado com resistência elástica aumenta a aptidão aeróbia: relato de caso

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ABSTRACT

Introduction: High-intensity interval training with elastic resistance (EL-HIIT) has promoted cardiorespiratory stimuli in active young people. It is not yet known whether obese individuals will present favorable adaptations in physical performance and body composition. **Objective:** To evaluate the effects of EL-HIIT on cardiorespiratory fitness, body composition, and affective response in an obese woman. **Methods:** Participant with BMI: 34.5 kg/m², 42 years old, physically inactive. The following were applied before and after 12 weeks of training: Cardiopulmonary treadmill exercise test, bioimpedance, and cardiopulmonary test with elastic resistance exercise. EL-HIIT was applied twice a week for 12 weeks (60s:60s – effort: recovery), at VT₂, starting with 6 sets, and progressing to another set/week, until reaching 10 sets. Affective responses and intensity (feeling scale, HR, RPE, OMNI-RES-EB) were monitored during and up to 30 min after the session. **Results:** EL-HIIT increased VO_{2max} (21.5%) and VO₂ of ventilatory threshold 1 (73.5%) and ventilatory threshold 2 (46.6%). Fat-free mass increased (3.9%), and skeletal muscle mass increased (5.9%). The affective response increased during (1st = 1.2; 6th = 1.5; 12th = 2.3) and post-session (1st = 1.7; 6th = 3.0; 12th = 3.5). **Conclusion:** EL-HIIT applied for 12 weeks in an obese woman promoted substantial improvements in cardiorespiratory fitness, a positive affective response in addition to a slight improvement in body composition.

Keywords: affect; high-intensity interval training; cardiorespiratory fitness.

RESUMO

Introdução: O treinamento intervalado de alta intensidade com resistência elástica (EL-HIIT) tem se destacado por promover estímulos cardiorrespiratórios em jovens ativos. Ainda não se sabe se indivíduos obesos apresentarão adaptações favoráveis de desempenho físico e na composição corporal. **Objetivo:** Avaliar os efeitos do EL-HIIT na aptidão cardiorrespiratória, composição corporal e resposta afetiva em uma mulher obesa. **Métodos:** Participante com IMC: 34,5 kg/m², 42 anos, fisicamente inativa. Foram aplicados antes e após 12 semanas de treinamento: Teste cardiorrespiratório de exercício na esteira, bioimpedância e o teste cardiorrespiratório com resistência elástica. O EL-HIIT foi aplicado 2x por semana por 12 semanas (60s:60s – esforço: recuperação), prescrito na intensidade do limiar ventilatório 2, iniciando com 6 séries, e progredindo para mais uma série/semana, até alcançar 10 séries. A intensidade e a valência afetiva (FC, PSE, OMNI-RES, Escala afetiva) foram monitoradas durante e até 30 min após sessão. **Resultados:** O EL-HIIT aumentou o VO_{2max} (21,5%) e o VO₂ do limiar ventilatório 1 (73,5%) e do limiar ventilatório 2 (46,6%). A massa livre de gordura aumentou (3,9%), e massa muscular esquelética aumentou (5,9%). A resposta afetiva aumentou durante (1ª = 1,2; 6ª = 1,5; 12ª = 2,3) e pós-sessão (1ª = 1,7; 6ª = 3,0; 12ª = 3,5). **Conclusão:** O EL-HIIT aplicado por 12 semanas em uma mulher obesa promoveu melhorias substanciais na aptidão cardiorrespiratória, resposta afetiva positiva além de melhora discreta na composição corporal.

Palavras-chave: afeto; treinamento intervalado de alta intensidade; aptidão cardiorrespiratória.

Introduction

Physical inactivity and sedentary behavior, as identified by the World Health Organization [1], are robust predictors for the development of chronic non-communicable diseases, including type II diabetes, cardiovascular diseases, hypertension, certain types of cancer, and obesity. Obesity is a multifactorial chronic condition influenced by factors such as genetic predisposition, social and biological determinants, sedentary lifestyle, and poor dietary habits [1]. To mitigate the progression of the obesity epidemic, programs and policies that promote improvements in eating habits and regular physical activity are proposed [1,2].

Physical exercise is crucial in controlling obesity and mitigating its associated morbidities. The Brazilian Association for the Study of Obesity and Metabolic Syndrome suggests combining aerobic exercises (either continuous or intermittent) with resistance exercises [1]. The recommended duration for regular aerobic exercise for individuals with obesity is 250 to 300 minutes per week at a moderate intensity, and resistance exercises are advised to be performed 2-3 times a week, targeting large muscle groups [3].

However, a large part of the adult population cannot meet the recommendations determined by the guidelines. Furthermore, women are more likely than men to be physically inactive [4]. The main physical barriers to physical activity are physical pain/discomfort, fatigue/lack of energy, and health problems. The socio-ecological barriers to practicing physical activity appear to be the lack of time and social support. Psychological barriers to practicing physical activity are lack of self-discipline/motivation, lack of interest/fun, lack of skills/confidence, and negative affective response to exercise [5-7].

It has been observed that the affective response, characterized by feelings of pleasure or displeasure, is influenced by the intensity of exercise. Obese individuals, in particular, may encounter difficulties in tolerating high-intensity exercise [8]. Continuous high-intensity exercise can induce unpleasant feelings, posing challenges to sustaining adherence to the exercise regimen [9-11]. This notion is aligned with the Dual Model Theory [12], which postulates that when exercise intensity exceeds physiological limits (e.g., ventilatory threshold 2), affective responses tend to be more negative, influenced by interoceptive factors such as lack of exercise. Shortness of breath, pain, and fatigue negatively impact future exercise participation. However, evidence suggests that high-intensity training, particularly interval training (HIIT), can elicit a positive affective response to exercise [13].

In this sense, high-intensity interval training (HIIT) can be a favorable exercise modality to reduce barriers to low adherence to physical exercises, such as the feeling of displeasure and lack of time, enabling physiological adaptations favorable to health. HIIT is characterized by intermittent high-intensity efforts (85-100% VO_{2max} or 90-100% HR_{max}), followed by interspersed periods of active or passive rest [14,15]. Studies have shown that HIIT can improve oxidative capacity, insulin sensitivity, and cardiorespiratory fitness [14-16].

Many studies employing traditional HIIT often utilize high-cost equipment like treadmills and exercise bikes, posing accessibility challenges. A novel and cost-effective alternative is Elastic Resistance High-Intensity Interval Training (EL-HIIT), which can be performed in diverse spaces. Recent studies using interval exercise with elastic resistance have demonstrated essential reductions in blood pressure and blood glucose after exercise [17,18] and has the potential for developing cardiorespiratory fitness [19]. Gasparini-Neto *et al.* [17] demonstrated that an interval exercise session with elastic resistance reduced blood pressure and blood glucose in older women with and without hypertension. However, the effectiveness of high-intensity interval training with elastic resistance (EL-HIIT) in promoting long-term cardiorespiratory improvements is still unknown, and no studies of this training in obese individuals have been found.

Therefore, this study aims to evaluate the effects of a high-intensity interval training program with elastic resistance (EL-HIIT) on cardiorespiratory fitness, body composition, and affective response over 12 weeks in an obese woman. The secondary objective is to describe the acute responses of heart rate (HR), perceived exertion (RPE), and affective response (AR) to the EL-HIIT program.

Methods

Study design

A longitudinal case study was carried out. The procedures and training protocol were explained to the volunteer, and after this stage, the free and informed consent form was signed. This subproject is a supplementary study of the project approved by the Human Research Ethics Committee of the Federal University of Espírito Santo (CAAE 09109319.2.0000.5542). OBHIIT Study (PRPPG/UFES, No. 9306/2019).

Subject

The subject was selected for convenience. A woman with a body mass index classified as class I obesity (BMI 34.5 kg/m²), 42 years old, physically inactive (\leq 150 min/week of physical exercise).

Procedures

For the initial assessments, the volunteer completed two visits at intervals of at least one week to the Exercise Physiology laboratory (LAFEX/UFES). The first two visits were dedicated to procedure familiarization and body composition assessment. Specific maximal tests followed, including a cardiopulmonary test on the treadmill to evaluate cardiorespiratory fitness and an incremental test with elastic resistance. The latter was employed to prescribe the exercise session at the stage corresponding to ventilatory threshold 2. Then, there was a twelve-week training period, where physiological and affective responses were monitored for monitoring in the study. After six weeks, the incremental test with elastic resistance was repeated to realign the

training. Finally, after twelve weeks, the assessments were reapplied to characterize the chronic effects of EL-HIIT.

Anthropometric assessment and body composition

Body mass and height were assessed using a digital anthropometric scale with a one-millimeter precision stadiometer (Marte Científica, L200, São Paulo) to calculate the Body Mass Index (BMI). Body composition was analyzed using a tetrapolar digital scale with eight electrodes (model InBody 270), with a maximum capacity of 250kg and frequencies of 20 and 100 kHz.

Cardiopulmonary exercise testing (CPX)

The CPX was performed before and after EL-HIIT to assess cardiorespiratory fitness. The test was applied on a motorized treadmill (Inbra Sport Super ATL, Porto Alegre, Brazil) maintained at a 1% incline with a warm-up of 3 minutes of walking at 3 km·h⁻¹, the speed was increased by 0.5 km·h⁻¹ every minute until the volunteer reached exhaustion. The protocol used aimed to last between 6 and 12 minutes [20]. The volunteer received verbal encouragement to advance through the test stages to maximum effort. With breath-by-breath collection, ventilation, and gas exchange variables were measured using a metabolic gas analyzer (model Cortex Metamax 3B, Germany). Then, 20-second averages were calculated and analyzed using the MetaSoft program. The Cortex unit was calibrated using the closed-circuit method, using calibration gas (original 16%O₂ and 5%CO₂ cylinder supplied by the manufacturer), which allowed a new calibration before each test. The criteria for identifying the test as maximum consisted of accepting at least three of the following criteria: a) voluntary exhaustion; b) Maximum HR reached of at least 90% of that predicted for age (220-age); c) respiratory exchange ratio equal to or above 1.1; d) maximum consumption by the plateau or peak of oxygen.

Cardiopulmonary exercise test with elastic resistance (CPX-EL)

The CPX-EL was administered following the protocol proposed by Gasparini-Neto [21]. The test was carried out on a 4.5-meter-long rubber mat, with 11 demarcations in a line (0 to 10) with a spacing of 30 centimeters between them and with white and black colors (Figure 1). An adjustable belt with a reinforced clasp placed at the height of the iliac crest was used, coupled to a 2 m silver elastic tube (Thera Band®, Akron, OH, USA) (Figure 2). The elastic tube was checked for safety at each session and replaced when it showed weakness or increased by 2 cm to its original size. The test consisted of alternating steps forward and backward against elastic resistance attached to a belt. Before starting the test, the belt, the silicone facial mask for gas collection, and the heart rate sensor (Polar, T31 CODED) were placed. After a 3-minute warm-up (S0), a protocol was carried out consisting of increments of 1 stage (60cm) per minute following a cadence of 132bpm (beats per minute) on an 8-stage rubber mat. During the test, the volunteer was encouraged to follow the rhy-

thm emitted by a metronome (Cell Phone Application - ®Cifraclub). The cadence was controlled with a metronome at 112 bpm during the warm-up and 132 bpm during the stages. A new incremental test with elastic resistance was performed in the sixth week of training to adjust the exercise intensity. The intensity was maintained, and the following sessions were carried out at the same stage, following the same value obtained in the initial test.

Determination of ventilatory thresholds

The ventilatory threshold 1 (VT1) was identified at the moment of the lowest point, followed by an exponential increase in the ventilatory equivalent of oxygen (VE/VO_2), without an increase in the ventilatory equivalent of carbon dioxide (VE/VCO_2). The abrupt increase in partial pressure of oxygen in exhaled air ($PetO_2$) was also used as a secondary criterion. To identify the ventilatory threshold 2 (VT2), the moment of the lowest point of VE/VCO_2 was considered with a subsequent increase beyond the moment of the gradual fall in $PetCO_2$.

To identify the ventilation thresholds, three evaluators, independently and blindly, defined the results, considering the points of agreement of at least two evaluators.

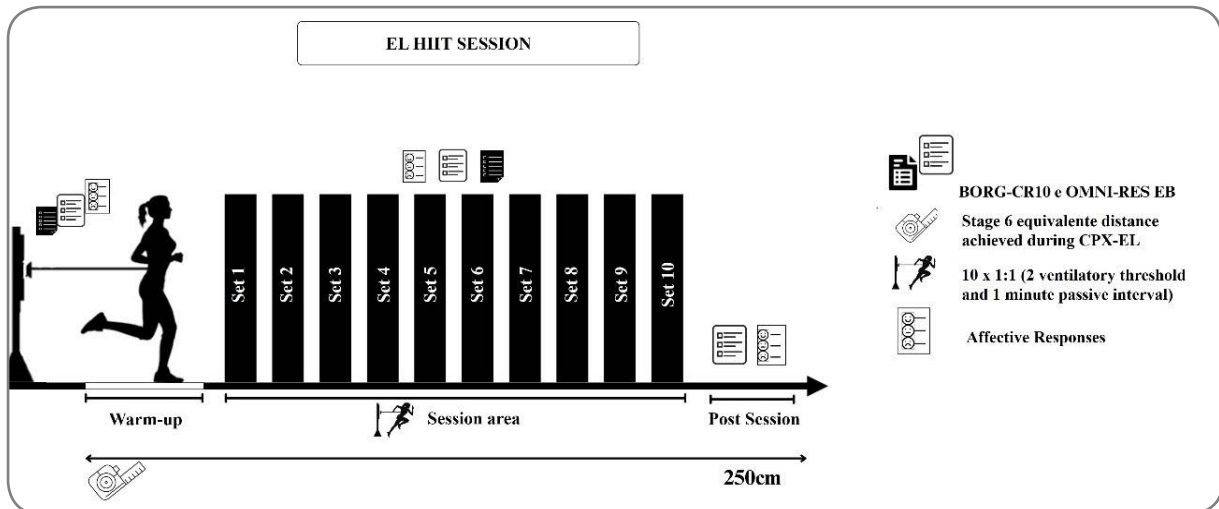
Heart rate

Heart rate was monitored continuously during the sessions using the POLAR H10 heart rate monitor (Polar Electro Oy, Kempele, Finland). The intensity reached during the sessions was calculated with the values obtained, which were expressed in $\%HR_{max}$ values.

Training program - EL-HIIT

The EL-HIIT program lasted twelve weeks, consisting of two weekly sessions, totaling twenty-four sessions. In the first EL-HIIT session, six sets were performed in total. A new series was added from the second to the fifth week of training, totaling ten series per session. This configuration of ten sets was maintained throughout training until the twelfth week (Figure 1). After six weeks, the incremental test with elastic resistance was repeated to realign the training, but during this period, there was no need for changes in the training load. The sessions took place in an air-conditioned gym. The volunteer used an adjustable belt with reinforced closure, to which a 2-meter elastic tube (®Thera-band Tubing, Malaysia) was attached. The elastic tube was checked for safety aspects at each session and replaced when it showed any weakness or increased by 2 cm about its original size, which occurred in the third, eighth, and last week of training. Heart rate was monitored throughout the session using a heart rate monitor. The exercise series lasted one minute, performed at an intensity equivalent to VT2 determined by CPX-EL (Stage 6), with a passive interval of one minute between series, protocol 10 x 60s:60s [19]. The volunteer was encouraged to follow the rhythm emitted by a metronome (Cellphone Application - ®Cifraclub).

The cadence was controlled with a metronome at 112 bpm during the warm-up and 132 bpm during the sets.



Feeling scale, perceived exertion BORG-CR10 and OMNI-RES EB; Session area - distance in centimeters: equivalent to stage 6 reached by the volunteer during the CPX-EL

Figure 1 - Design of EL-HIIT sessions, 3-minute warm-up, 6-10 x 1-minute (Ventilatory Threshold 2) and 1-minute passive interval

Affective response (AR)

AR was assessed using the Feeling Scale (FS). The FS is an 11-point scale ranging from -5 (“very bad”) to +5 (“very good”), which evaluates the sensation of pleasure/displeasure provided by physical exercise [22]. The volunteer responded as follows: “How are you feeling right now? The scale was applied at the beginning (before the session), during (at the end of each series), and at the end of the session (immediately after and 10/30 minutes after) throughout the EL-HIIT program.

Rating perceived exertion (BORG CR-10 and OMNI-RES EB scales)

The rating perceived exertion (BORG-CR-10) [23,24] was applied at the end of each series and the end of the session (immediately and 10/30 minutes later). The volunteer classified the perceived effort as the general effort. The OMNI-RES 0–10 scale, developed to evaluate the perception of peripheral effort, with an adaptation made using an elastic band [25,26], was applied at the end of each series of the EL-HIIT session. The volunteer classified the perceived effort as a peripheral effort.

Data analysis

Data on VO_{2max} , HR_{max} , BORG-CR10, OMNI-RES EB, feeling scale, and body composition were presented in absolute and percentage values.

Results

EL-HIIT promoted a 21.5% increase in VO_{2max} compared to pre-training measurements without any impact on maximum speed (V_{max}) and maximum heart rate (HR_{max}) (Table I). In the submaximal parameters evaluated by CPET, they showed increases of 73.5% in VO_2 , 85.7% in speed, and 40% in HR of ventilatory threshold 1, and increases of 46.6% in VO_2 , 16.6% in speed and 21.3% in heart rate, at ventilatory threshold 2 (Table II). Body composition measurements showed changes during the pre-training and post-training period. An increase in body mass of 3.7% was identified, accompanied by a 2% increase in fat mass. Despite this, there was an increase of 3.9% in fat-free mass and 5.9% in skeletal muscle mass, with a 1.7% reduction in fat percentage (Table III).

Table I - Chronic effects of EL-HIIT on maximum cardiorespiratory parameters

	Pre	(%)Max	Post	(%) Max	Diff.(%)
VO_{2max} (ml·kg ⁻¹ ·min ⁻¹)	20.9	57.4	25.4	70.5	+4.5 (21.5)
V_{max} (km·h ⁻¹)	9.0	0	9.0	0	0 (0)
HR_{max} (bpm)	174	97.2	176	98.3	+2 (1.14)

VO_{2max} = maximum oxygen consumption; V_{max} = maximum velocity reached in CPX; HR_{max} = maximum heart rate; (%) Predicted max: % of predicted VO_{2max} for sex and age group; Diff. (%) difference between pre-training and post-training in absolute and relative value

Table II - Chronic effects of EL-HIIT on submaximal cardiorespiratory parameters

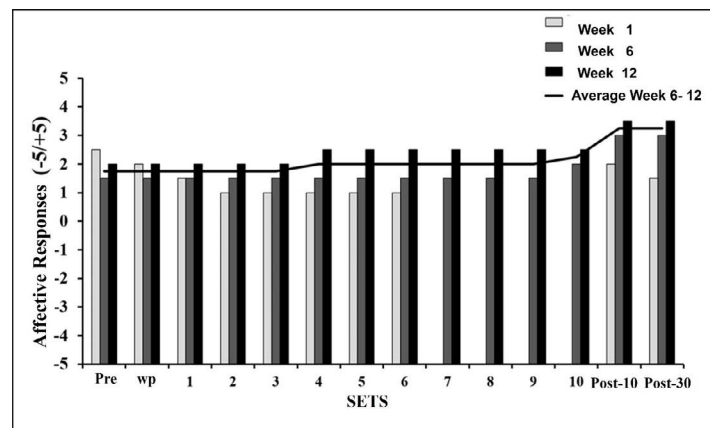
Measures	Pre	%Máx.	Post	%Máx.	Diff. (%)
VO_2LV1 (ml·kg ⁻¹ ·min ⁻¹)	8.7	41.8	15.1	59.4	+6.4 (73.5)
vLV1 (km·h ⁻¹)	35	38.9	6.5	72.2	+3 (85.7)
FCLV1 (bpm)	95	54.6	133	75.6	+38 (40)
VO_2VT2 (ml·kg ⁻¹ ·min ⁻¹)	13.3	55.6	19.5	76.6	+6.2 (46.6)
vLV2 (km·h ⁻¹)	6.0	66.6	7.0	77.7	+1 (16.6)
FCLV2 (bpm)	122	70.1	148	84.1	+26 (21.3)

VO_2VT1 = oxygen consumption at ventilatory threshold 1; VO_2VT2 = Oxygen consumption at ventilatory threshold 2; FCVT1 = Heart rate at ventilatory threshold 1; FCVT2 = Heart rate at ventilatory threshold 2; vVT1 = velocity reached at ventilatory threshold 1; vVT2 = velocity reached at ventilatory threshold 2; %Max = Percentage of maximum values evaluated; Diff. (%). Difference between pre-training and post-training absolute value and percentage of difference

Table III - Chronic effects of EL-HIIT on body composition

Parameters	Pre	Post	Abs.Diff. (%)
Weight (kg)	86.2	89.4	+3.2 (3.7)
Skeletal Muscle Mass (kg)	23.1	24.4	+1.3 (5.6)
Fat mass (kg)	44.2	45.1	+0.9 (2.0)
Fat-Free Mass (kg)	42.0	43.3	+1.3 (3.9)
Fat percentage (%)	51.3	50.4	-0.9 (1.7)

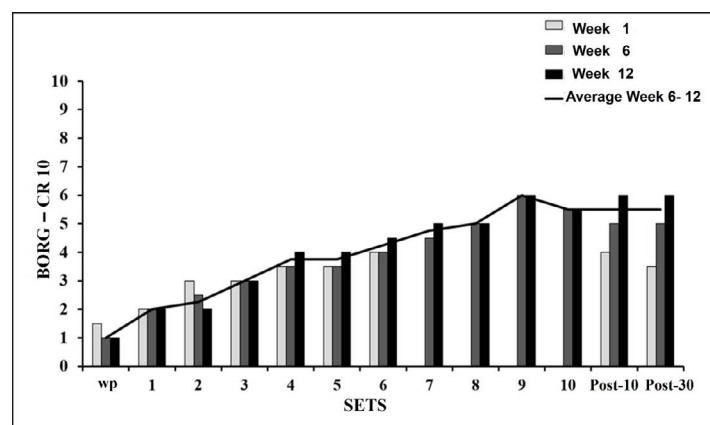
In the analysis of AR throughout the 1st, 6th, and 12th week of EL-HIIT training, an increase in AR was noticed throughout the sessions when comparing the average value between sessions (1st = 1.2 vs. 6th = 1.5 vs. 12th = 2.3) and post-session (1st = 1.7 vs. 6th = 3.0 vs. 12th = 3.5) (Figure 2).



Pre = Pre-session; wp = warm-up; Sets:1 to 10; post-10 and post-30 = after ten and thirty minutes of the session

Figure 2 - Average values of the affective response during the 1st, 6th, and 12th week of the training program

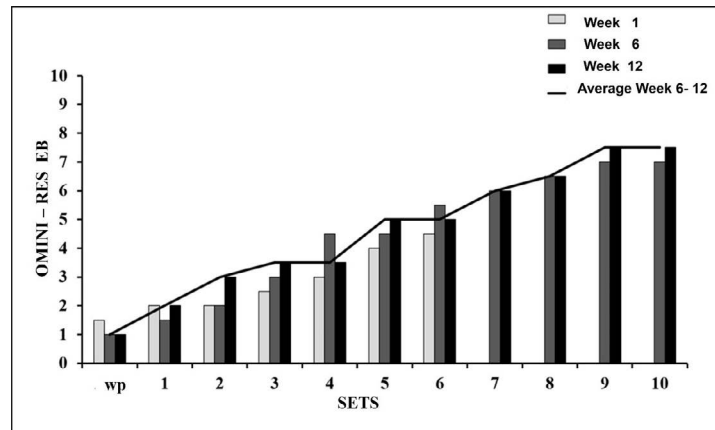
Using the RPE averages during the session in the 1st, 6th, and 12th weeks, there was an increase in the perception of effort during the EL-HIIT program (1st = 3.3 vs. 6th = 4.1 vs. 12th = 4.4). RPE can also be noticed at moments 10 and 30 minutes after exercise (1st = 3.8 vs. 6th = 5.0 vs. 12th = 6.0) (Figure 3).



Wp = warm-up; sets = 1 to 10; post-10 and post-30 = after ten and thirty minutes of the session

Figure 3 - Average values of subjective perception of general effort during the training program's 1st, 6th, and 12th week

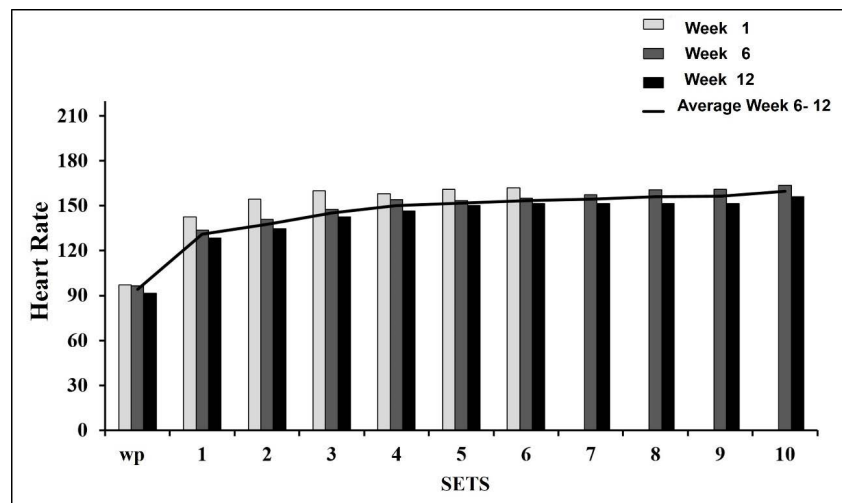
The same analysis of the means was carried out with the OMNI-RES EB scale, collected during the session, and it was possible to identify an increase in the perception of peripheral effort during the EL-HIIT sessions (1st = 3.0 vs. 6th = 4.7 vs. 12th = 4.9) (Figure 4).



Wp = warm-up; sets =1 to 10

Figure 4 - Average values of subjective perception of peripheral effort during the training program's 1st, 6th, and 12th week

In the average analysis of HR, in the 1st, 6th, and 12th weeks of EL-HIIT training, a slight reduction in HR was noticed throughout the sessions, especially when comparing the 6th and 12th week of training (1st = 148 bpm vs. 6th = 148 bpm vs. 12th = 141 bpm) (Figure 5).



Wp = warm-up; sets =1 to 10

Figure 5 - Average heart rate values during the training program's 1st, 6th, and 12th week

Discussion

This study investigated the effect of a high-intensity interval-training program with elastic resistance (EL-HIIT) on cardiorespiratory fitness, body composition, and affective response over 12 weeks in a case study with an obese woman. The main findings were: a) EL-HIIT application resulted in significant improvements in cardiorespiratory fitness, evident in both maximal ($\text{VO}_{2\text{max}}$) and submaximal (VT1 and VT2) levels. Substantial increases were observed in submaximal work, as indicated by velocity achieved at the respective ventilatory thresholds. b) Concerning body composition parameters, no reduction in body fat was found. Despite this, there was an increase in fat-free mass and skeletal muscle mass. c) Furthermore, the program provided a positive affective response (AR) during the 12 weeks of training, with an increase in AR compared to the 1st with the 6th and 12th weeks.

The effect of EL-HIIT on increases in cardiorespiratory parameters is a significant finding since it is well described in the literature that improvements in $\text{VO}_{2\text{max}}$ are a key indicator in reducing the risk of morbidity and mortality from all causes [27]. These authors point out that an increase in $\text{VO}_{2\text{max}}$ of 3.5 mL/kg/min is associated with a reduction in the risk of mortality between 10% and 25% in men and women. Reljic *et al.* [28] showed that a low-volume HIIT protocol lasting 12 weeks (2 sessions per week) in people with obesity promoted an increase in $\text{VO}_{2\text{max}}$ of 4.5 mL·kg⁻¹·min⁻¹. This result is similar to that found in the present study, which applied a HIIT program with elastic resistance (EL-HIIT- 12 weeks – twice a week) and increased $\text{VO}_{2\text{max}}$ of 4.5 mL·kg⁻¹·min⁻¹. Furthermore, Kaminky *et al.* [29] reinforce the clinical value of cardiorespiratory fitness, expressed by $\text{VO}_{2\text{max}}$, for estimating health-related risk when estimating the risk for cardiac events and premature mortality. It is important to highlight that $\text{VO}_{2\text{max}}$ decreases with age, and, therefore, the increase in $\text{VO}_{2\text{max}}$ has a reverse effect on the aging process. Adaptations in $\text{VO}_{2\text{max}}$ are associated with an increase in cardiac function, such as an increase in maximum cardiac output (determined by the product of heart rate and stroke volume) and peripheral adaptations in oxygen supply (arteriovenous O₂ difference) [30]. In this study, it was not possible to investigate cardiac function. However, the peripheral adaptations related to the muscular component can be interpreted by the association of the anaerobic threshold, measured by the ventilatory threshold, with the increase in glycolytic metabolism [31,32]. Therefore, the percentage increase in VO_2 observed at ventilatory thresholds 1 and 2 (73.5% $\text{VO}_2\text{VT1}$ and 46.6% $\text{VO}_2\text{VT2}$) demonstrates an improvement in muscle oxidative function, as the collaboration of the glycolytic pathway to perform work was shifted to a higher intensity and High effort [31]. This is confirmed by the increase in submaximal work performed, expressed by the velocity performed at the respective ventilatory thresholds (vVT1 of 85.7% and vVT2 of 16.6%), which reflects the increase in the ability to perform work with more comfort before subjecting the body to exacerbated ventilatory responses, which is observed during the metabolic acidosis buffering mechanism, pertinent to the anaerobic threshold [32,33].

Increased ventilatory thresholds are known to be linked to peripheral adaptations such as increased capillary density in trained muscles. This is due to increased maximum blood flow in the muscles. This increase in density provides a slow transit of red blood cells in the muscle, which causes the time needed for oxygen diffusion, which is benefited by the mitochondrial increase in skeletal muscle [34]. Furthermore, EL-HIIT caused changes in body composition. Despite there being an increase in body weight of ~3.7%. This result may be associated with increased skeletal and fat-free mass. Studies indicate that HIIT can promote hypertrophy and gain in muscle mass because type II fibers are heavily recruited in this modality [35,36]. However, the present study found no fat mass (kg) reduction. Batacan *et al.* [37] in a meta-analysis study, demonstrated that HIIT (≤ 12 weeks) was not able to promote improvements in fat loss in overweight and obese people. Ramírez-Vélez *et al.* [38] applied HIIT and found a reduction in body fat using a training protocol with a higher weekly frequency (3x per week) associated with dietary control with caloric restriction. In addition, we did not control caloric intake, which can explain these findings.

Regarding AR, the dual model theory postulates that interoceptive factors such as pain, fatigue, and acidosis are pronounced when continuous exercise is performed at high intensity. High intensity provides a negative AR and makes it challenging to practice regular physical exercise [12]. High-intensity continuous exercise applied mainly to less trained and sedentary individuals can cause an exacerbated stressor effect, making it challenging to adhere to a vigorous exercise program [39]. Although HIIT is performed at high intensity, several studies have shown that HIIT can provide a positive AR to exercise in different populations [40–43]. These findings can be explained, in part, by the intermittent characteristic of HIIT, as recovery periods between sets can reduce the sensation of pain and discomfort, making HIIT more tolerable [43].

Furthermore, the constant change between stimuli and intervals can reduce the monotony of the session, making HIIT more enjoyable [44]. Furthermore, studies that evaluated AR in HIIT protocols over several sessions also found positive AR for HIIT and a high rate of adherence to training. According to these findings, our study demonstrated that despite the high intensity during the EL-HIIT sessions, AR increased during the program, even with the increase in RPE and OMNI-RES EB.

Limitations and future perspectives

Although the findings are very promising for the effects on cardiorespiratory fitness, body composition, and affective valence, it is important to note that this is a case study and, therefore, it is not possible to generalize these results. Furthermore, it is important to highlight that although the session's intensity was monitored rigorously, eating habits were not monitored in the same way, which may have included biases in the body composition findings. However, this study opens the door for new studies of intervention that use elastic resistance in different populations and presents an appropriate study design, especially for randomized clinical trials.

Conclusion

The EL-HIIT applied to an obese woman promoted substantial improvements in cardiorespiratory fitness, complemented by modest adaptations in body composition. Furthermore, the training was well tolerated for 12 weeks with good adherence, showing a positive and increasing affective response.

Academic affiliation

This article is the result of the Institutional Scientific Initiation Program of the Federal University of Espírito Santo (UFES) by undergraduate student Julieny Pita de Oliveira, supervised by professor Luciana Carletti, Ph.D. in Physiological Sciences, UFES - Avenida Fernando Ferrari, 514, Goiabeiras, CEP: 29075-910, Vitória - Espírito Santo - Brazil.

Conflict of interests

The authors declare that no known competing financial conflicts of interest or personal relationships could have influenced the work reported in this article.

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Author's contributions

Conception and design of the research: Nunes LB, Carletti L, Neves LNS, Gasparini-Neto VH; **Data acquisition:** Neves LNS, Gasparini-Neto VH; **Data analysis and interpretation:** Oliveira JP, Neves LNS, Carletti L, Gasparini-Neto VH, Nunes LB; **Statistical analysis:** Nunes LB, Oliveira JP; **Manuscript writing:** Oliveira JP, Carletti L, Neves LNS, Gasparini-Neto VH, Nunes LB; **Critical review of the manuscript for important intellectual content:** Carletti L, Neves LNS, Gasparini-Neto VH, Nunes LB

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