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Original article

Affective responses to a high-intensity kettlebell training program: pilot study

Respostas afetivas de um programa de treinamento de alta intensidade com kettlebell: estudo piloto

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ABSTRACT

Introduction: Although exercise benefits health, women have high levels of physical inactivity. Lack of time and negative affective responses to exercise can be barriers to adherence to training programs for this population. Thus, studies must investigate the affective responses (ARs) resulting from short-duration exercise protocols. In this sense, high-intensity kettlebell training can be an interesting strategy. **Objective:** This study aimed to characterize acute and chronic affective responses of young women during a high-intensity kettlebell training program. **Methods:** Eleven volunteers (aged 25 ± 3 years) participated for ten weeks in high-intensity kettlebell training (3x per week). The program was applied using a familiarization period, followed by three phases using swing and squat exercises. **Results:** No significant differences were observed when comparing the affective responses obtained pre-session with the measurements at 5, 10 and 20 min post-session in the acute phase ($p > 0.05$). Still, no significant differences were observed over the ten weeks of training (Pre = 2.13 ± 0.26 / 5 min = 1.92 ± 0.42 / 10 min = 1.89 ± 0.43 / 20 min = 1.93 ± 0.44) ($p > 0.05$). **Conclusion:** The high-intensity kettlebell training program with progressive and individualized load increases can maintain positive affective responses in the acute phase and after ten weeks of training.

Keywords: affect; high-intensity interval training; exercise.

RESUMO

Introdução: Apesar da prática de exercício ser benéfica para a saúde, mulheres apresentam níveis elevados de inatividade física. A falta de tempo e as respostas afetivas (RAs) negativas ao exercício podem ser barreiras à aderência aos programas de treinamento para essa população. Assim, é importante que estudos investiguem as RAs decorrentes de protocolos de exercício de curta duração. Nesse sentido, treinamento com kettlebell de alta intensidade pode ser uma alternativa interessante. **Objetivo:** O objetivo deste estudo foi caracterizar as RAs agudas e crônicas de mulheres jovens submetidas a um programa de treinamento com kettlebell de alta intensidade. **Métodos:** Onze voluntárias (idade = 25 ± 3 anos) participaram por 10 semanas de treinamento com kettlebell de alta intensidade (3x por semana). O programa foi aplicado utilizando um período de familiarização, seguidos por três fases utilizando os exercícios swing e agachamento. **Resultados:** Não foram observadas diferenças significativas quando comparadas as RAs obtidas antes da sessão com as medidas de 5,10 e 20 min após a sessão na fase aguda ($p > 0,05$). Ainda, não foram observadas diferenças significativas ao longo das 10 semanas de treinamento (Pré = 2,13 ± 0,26 / 5 min= 1,92 ± 0,42 / 10 min = 1,89 ± 0,43 / 20 min = 1,93 ± 0,44) ($p > 0,05$). **Conclusão:** O programa de treinamento com kettlebell de alta intensidade com aumento progressivo e individualizado de carga pode manter RAs positivas na fase aguda, e após 10 semanas de treino.

Palavras-chave: afeto; treinamento intervalado de alta intensidade; exercício físico.

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Introduction

The regular practice of physical exercise (PE) provides several health benefits, such as the reduced risk of cardiovascular disease, high blood pressure, cancer, and diabetes and improved mental health [1]. Despite this, the adult population consumes considerable time in sedentary habits. Furthermore, women exhibit higher levels of physical inactivity (31.7%) compared to men (23.4%), which calls attention to further investigation of this group [2,3].

It is known that there are barriers to adherence to PE programs, such as the ARs experienced during the sessions, the monotony imposed by continuous sessions of long duration, and lack of time [4-8]. ARs represent the sensation of pleasure/displeasure experienced during PE. These responses can contribute to a positive or negative memory trace formation concerning PE and seem to influence future decisions to engage or not practice PE [6,9,10]. For example, evidence indicates that sedentary individuals who increase only one unit in ARs to PE (feelings scale from +5 to -5) may show an increment of 38 and 41 minutes per week in physical activity (PA), six months and 12 months after the intervention, respectively [11].

Studies with traditional models of PE (i.e., treadmill/bike) indicate a relationship between AR and intensity [12–14]. According to the dual-mode theory, when the PE intensity exceeds the metabolic thresholds (e.g., ventilatory threshold 2 or lactate threshold), the ARs tend to be more negative and may negatively impact the adherence to PE [15]. On the other hand, at lower and moderate intensities, ARs seem to be more positive [6,12,13,16].

In addition, lack of time is another important barrier reported to participation in PE. For this reason, high-intensity interval training (HIIT) programs can be a favorable strategy to increase the PA level for a shorter execution time. Furthermore, HIIT can be considered less monotonous than moderate-intensity continuous training (MICT) and provide benefits in physical fitness and health similar to or even superior to MICT [4,5,7,8,17,18]. However, studies about ARs related to HIIT are still inconclusive. This is because the different ways of manipulating the HIIT prescription variables (e.g., duration of effort and rest and effort: rest ratio) can impact ARs [19–21].

Still, the type of PE can also impact ARs to HIIT because the amount of muscle mass involved and the force generation required during PE leads to different physiological stress levels at similar relative intensities [22]. In this sense, it is necessary to understand the HIIT ARs according to the type of PE used, especially in protocols that involve large muscle groups, such as HIIT with a kettlebell.

Kettlebell HIIT (HIIT-KB) protocols consist of short duration (≤ 30 min) and high intensity (87-93% heart rate) sessions with 15-60 seconds of dynamic exercise involving the whole body [23-29] and have been shown to be beneficial for the improvement of important health parameters [30,31]. For example, previous studies have shown that HIIT-KB promoted improved aerobic capacity [30] and mental health in healthy young women, with reduced symptoms of depression [31]. However, to our knowledge, no studies have evaluated the ARs experienced during a HIIT-KB program.

This is an important fact since studies that evaluate ARs over several sessions can provide a closer representation of the behavior of this parameter from session to session, under the influence of intervening factors, reproducing an environment close to that experienced by the participant in the real world [11,19].

Therefore, the present study aimed to characterize acute and chronic ARs of young women after ten weeks of HIIT-KB. Our primary hypothesis is that HIIT-KB can provide acute positive ARs in sedentary young women. The secondary is that the HIIT-KB program with progressive and individualized load increase can generate a profile of positive ARs over ten weeks.

Methods

Sample

The study included 11 irregularly active women (24.6 ± 3.0 years) classified by the International Physical Activity Questionnaire (IPAQ). A statistical power of 0.8 was used to detect the main effects, alpha error of 0.05, a mean effect size (F = 0.25) for AR measures based on a previous resistance exercise study [32]. The inclusion/exclusion criteria were: age between 18 and 30 years old, no experience with kettlebell exercise, adequate physical/health conditions for testing and training (upon evaluation by a cardiologist), non-smoker, non-user of ergogenic or nutritional supplements and adherence to training > 85%.

The study was approved by the Research Ethics Committee (CEP/UFES), CAAE: 90506418.7.0000.5542.

Table I - Sample characterization (n = 11)

Body mass (kg)	62.32 ± 5.19
Stature (cm)	162.45 ± 5.57
BMI (kg/m^{-2})	23.75 ± 3.08
Fat percentage (%)	26.55 ± 6.16
PAL (MET)	314.55 ± 350.80

Values presented as mean ± SD. BMI = Body Mass Index; PAL = Physical Activity Level

Procedures

Anthropometry

Body composition was evaluated using the Pollock 7-fold protocol [33] to calculate the fat percentage. Height and body mass were determined using a stadiometer and a scale, respectively (*Mars scale, model LC200, Santa Rita do Sapucaí, MG, Brazil*). Body mass index (BMI, in kg/m^2) was calculated by dividing body mass by height squared.

Cardiological assessment of exertion

A test was performed on a motorized treadmill (*Inbra Sport Super ATL, Porto Alegre, Brazil*) maintained at 1% incline with a 5-min warm-up at 4 km·h^{-1}. An incremental protocol was used (1 km·h^{-1} at every min) until exhaustion. During the test, blood pressure (mercury column sphygmomanometer - Heidji) and heart rate were monitored with the MC5 lead (*Micromed digital ECG - Porto Alegre, Brazil*) and evaluated by a cardiologist. The highest heart rate (HR) value reached at the end of the test was recorded to monitor the intensity of the sessions. All participants were verbally encouraged during the test.

Heart rate

The heart rate (HR) was measured at the end of each series (*Polar Electro OY A300, Kempele, Finland*), and an average was calculated to characterize the intensity of the session (%HR_{max}).

Adherence to training

Participants' adherence to training was used to calculate the % of attendance using the formula: Number of sessions performed/Total number of sessions X 100. Participants were included in the study when they showed attendance ≥ 85% [34].

Total Training Load

The total training load was represented by the total volume in each phase (n° repetitions X n° series X weight of the kettlebell) [35], the weight of the kettlebell relative to body mass (%BM), and the percentage of the maximum heart rate reached in the sessions (%HR_{max}).

Affective valence

The 11-point "feelings scale" (FS) translated and adapted into Portuguese was used to assess ARs [36]. During training, anchors ranging from -5 (very bad) to +5 (very good) were used. The volunteers answered the following question: How are you feeling now? (at rest - 5, 10, and 20 min after the exercise session). The ARs were evaluated in all sessions, and an average of the 3 weekly sessions was performed.

Rating of perceived exertion

The session intensity was measured using the rating of perceived exertion (RPE) scale from 0 to 10 points [37,38]. At the end of each session (post-exercise 5, 10, and 20 min), together with the feelings scale, they answered the following question: How was your training? The scales were randomly used to avoid the influence of one measure over the other.

Kettlebell Training Protocol

The training protocol was divided into 3 phases (10 weeks): Phase I (2 weeks), Phase II (4 weeks), and Phase III (4 weeks). The sessions were three times a week

(Monday, Wednesday, and Friday). All sessions were preceded and ended with warm--up and cool-down (5 min each). The training phases were preceded by a two-week familiarization period, as described below [27,31].

Warm-up

At the beginning of each session, participants performed a warm-up (5 min). Then, the exercises aimed to recruit the muscle groups involved in kettlebell practice.

The following exercises were used: advancement with displacement, hip elevation with unipodal support, lateral trunk flexion in the sitting position, trunk rotation in the semi-kneeling position, trunk flexion, and extension in 4 supports. 15 repetitions were performed for each exercise, without rest intervals.

At the end, the participants performed the farmer's walk for 30s with two kettlebells with different loads (8 and 12 kg - Phase I, 12 and 16 kg - Phase II, 16 and 20 kg - Phase III) in each hand, and the kettlebell with the smallest load was supported in the chest region. For the last 20s, the kettlebells were switched sideways.

Familiarization

The participants underwent a two-week familiarization period, with three weekly sessions (Monday, Wednesday, and Friday). During this period, the exercises performed were respectively: hip flexion; deadlift; the first part of the swing, towel swing, kettlebell swing, wall squat, and kettlebell squat. The sessions consisted of 15 repetitions for each exercise and a 60s rest interval between sets.

During this period, the participants were familiarized with the scale of perceived exertion and the feelings scale.

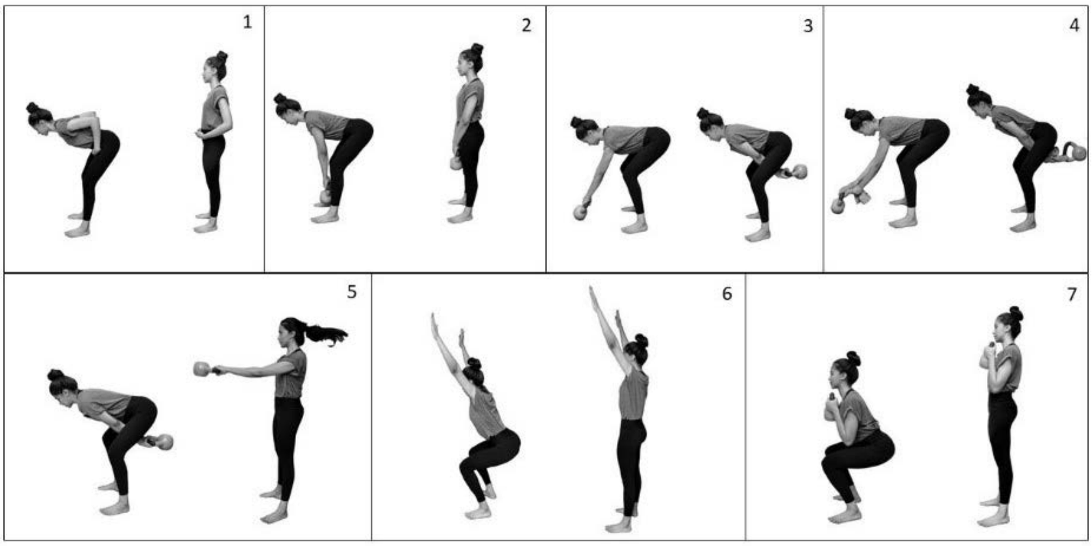


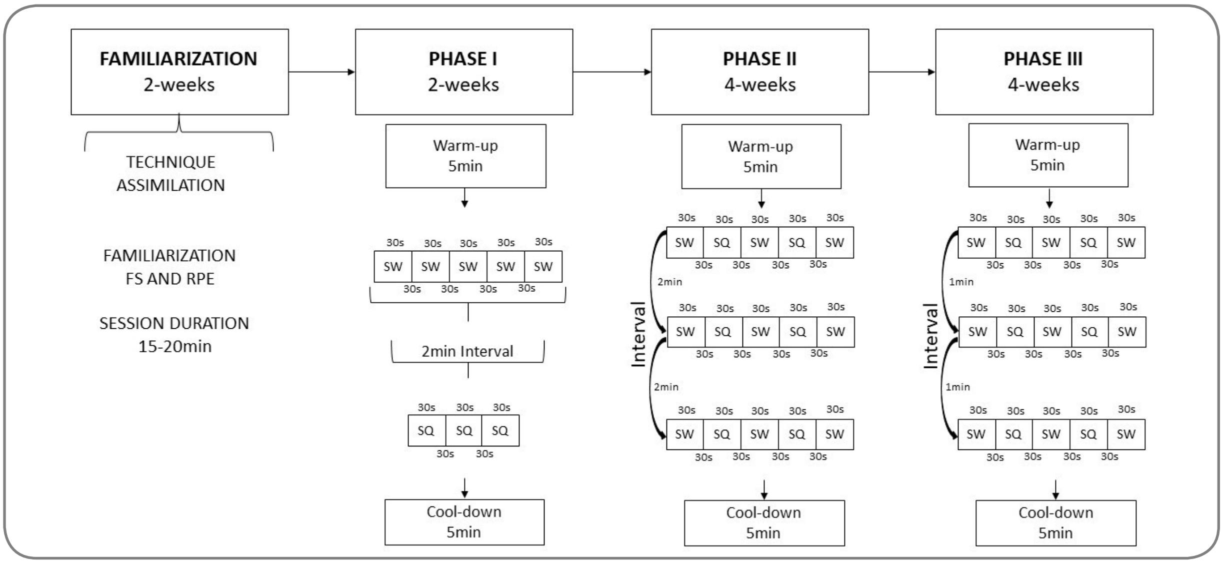
Figure 1 - Familiarization (1- hip curl; 2- deadlift; 3- the first part of the swing; 4- towel swing; 5- kettlebell swing; 6- wall squat; 6- kettlebell squat)

Phase I

During Phase I, two sets were used, consisting of five swing stimuli and three squat stimuli, respectively. From this training phase, the effort: pause ratio used was 30:30s, and the participants were encouraged to do as many repetitions as possible. In this phase, an interval of 2 min was adopted between sets.

Phase II e III

In the following four weeks (phase 2), the participants performed three sets of five stimuli, with an effort: pause ratio of 30:30s, alternating swing and squat movements, with a 2-minute break between sets. Phase III (four weeks) was similar to phase II. However, the interval adopted between sets was 1 min.



SW = Swing; SQ = Squat; FS = Feelings scale; RPE = Rating of Perceived
Figure 2 - High-intensity kettlebell training program. Exertion. Adapted from Zimerer *et al.*, 2021 [27]

Kettlebell Load Progression (kg)

The loads were increased on a scale of 4 kg at each progression [39], following the following criteria: I) RPE ≤ 5; II) Repetitions ≥ 23 swings; III) Technical execution [25,40]. However, participants were not informed about the load progression criteria to avoid any interference (blind progression).

Statistical Analysis

Statistical analysis was performed using IBM SPSS (Version 20.1). All data are presented as mean ± SD, and normality was confirmed by the Shapiro-Wilk test. One-way analysis of variance (ANOVA) with repeated measures and Sidak's post hoc were performed to analyze differences in training load between the 3 phases of the program. For all analyses, $p < 0.05$ was considered statistically significant. Two-way ANOVA for repeated measures and post hoc Sidak were used to analyze FS and RPE across training weeks and across the session [10 (weeks) x 3 - 4 (time)]. The AR was compared to the pre-exercise condition x recovery (5-, 10- and 20-min post-exercise). Furthermore, mean RPE values were compared during recovery (5, 10, and 20 min post-exercise).

Results

Adherence to training sessions at the end of the 10-week kettlebell program was 90%.

Training load

The quantification of a kettlebell training session in each phase (1, 2, and 3) showed that for the variables, kettlebell weight (kg), kettlebell weight relative to body mass (% BM), and total volume, there was a progressive and significant increase throughout the phases ($p < 0.05$). No significant differences were observed in the percentage of maximum heart rate during the program phases (~87% of HR_{max}) (Table II).

Table II - Total training load in each phase

	Phase I	Phase II	Phase III
Kettlebell weight (kg)	8.36 ± 1.20 $^{b, c}$	15.27 ± 2.41$^{a, c}$	18.18 ± 3.28 $^{a, b}$
% BM (kg)	13.4 5± 0.01$^{b, c}$	24.79 ± 0.04 $^{a, c}$	29.44 ± 0.06 $^{a, b}$
Reps	175.09 ± 11.09	263.54 ± 37.18^{a}	267.18 ± 17.33^{a}
Total volume A.U.	12241.45 ± 2526.83 ^{b,c}	60163.63 ± 12360.14$^{a, c}$	72943.63 ± 1500794.13^{a,b}
% HR_{max}	87.9 ± 7.0	90.3 ± 6. 26	90.4 ± 7.1

Mean ± SD of training load in phases 1, 2, and 3 of kettlebell training; %BM = kettlebell weight relative to body mass; A.U. = Arbitrary Units; %HR_{max} = Percentage of maximum heart rate; Reps = Repetitions; [a] =Significant difference compared to phase 1; [b] =Significant difference compared to phase 2; [c] =Significant difference compared to phase 3 ($p < 0.05$)

Affective response

There was no statistical difference for AR in the training weeks analyzed by two-way ANOVA (Table III) [$F (1.83, 18.3) = 3.435$; $p > 0.05$]. For the different measurement times, no statistical difference was observed either [F (2.74, 27.421 = 0.330; p > 0.05)]. The analysis of the time (sessions) x weeks (training program) interaction on AR did not reveal a significant effect.

Rating Perceived Exertion

Throughout the sessions (time), RPE 5, 10, and 20 min after exercise was statistically similar [$F (2, 20) = 0.982$; $p > 0.05$] but increased between weeks 2 and 3, and weeks 2 and 6, respectively [$F (2.45, 24.53) = 4.45$; $p < 0.05$]. There was an interaction between time and weeks for RPE values, showing that time had a different effect over the weeks (Table IV). There were no significant differences in RPE values after exercise (5-20min).

Table III - Affective scale values over the training weeks

	Measurement time			
Training weeks	Pre	Post 5	Post 10	Post 20
1	2.03 ± 1.38	2.40 ± 1.26	2.37 ± 1.30	2.46 ± 1.30
2	2.27 ± 1.08	2.51 ± 1.04	2.55 ± 1.04	2.55 ± 1.04
3	2.76 ± 0.94	2.29 ± 1.69	2.14 ± 1.95	2.27 ± 1.67
4	2.05 ± 1.31	2.06 ± 1.03	2.08 ± 1.00	2.14 ± 1.03
5	1.86 ± 1.61	2.09 ± 1.27	2.09 ± 1.27	2.15 ± 1.22
6	2.24 ± 1.22	1.45 ± 1.49	1.45 ± 1.49	1.42 ± 1.47
7	2.03 ± 1.37	1.26 ± 1.45	1.23 ± 1.50	1.26 ± 1.46
8	2.09 ± 1.05	1.88 ± 1.00	1.79 ± 0.97	1.79 ± 1.14
9	2.09 ± 0.84	1.64 ± 1.33	1.58 ± 1.36	1.73 ± 1.12
10	1.86 ± 1.68	1.62 ± 1.53	1.59 ± 1.61	1.56 ± 1.57

Values presented as mean ± SD. Two-way ANOVA for repeated measures

Table IV - Rating of perceived exertion values presented in mean and standard deviation over the time of session measurements and over the training weeks

	Measurement time		
Training weeks	Post 5	Post 10	Post 20
1	4.27 ± 0.88	4.06 ± 0.83	3.85 ± 0.83
2	3.64 ± 0.74	3.67 ± 0.75	3.64 ± 0.78
3	5.02 ± 1.27[a]	5.06 ± 1.36[a]	5.11 ± 1.39[a]
4	4.56 ± 1.16	4.63 ± 1.09	4.56 ± 1.10
5	4.85 ± 1.20	4.85 ± 1.20	4.82 ± 1.19
6	5.76 ± 1.08[a]	5.79 ± 1.05[a]	5.76 ± 1.02[a]
7	5.73 ± 1.30	5.79 ± 1.30	5.79 ± 1.30
8	5.18 ± 1.25	5.30 ± 1.33	5.30 ± 1.33
9	5.36 ± 1.86	5.42 ± 1.88	5.33 ± 1.84
10	5.33 ± 2.07	5.30 ± 2.07	5.30 ± 2.11

Values presented as mean ± SD. Two-way ANOVA for repeated measures. [a]Significant difference compared to week 2 ($p < 0.05$)

Discussion

The main finding of this study was that the 10-week HIIT-KB program (87-90%HR_{max}) maintained positive acute and chronic ARs, even with the progressive increase in kettlebell load (kg) throughout the intervention. The primary hypothesis of this study is that kettlebell exercise can evoke acute positive ARs in young sedentary women. The secondary hypothesis is that HIIT-KB with progressive and individualized load increase can generate a profile of positive ARs after ten weeks. Both hypotheses were confirmed.

According to the double model theory, at intensities above metabolic thresholds (ventilation threshold 2 or lactate threshold), ARs tend to be negative due to increased acidosis, pain, and fatigue [6,15]. Given this, it would be expected that high-intensity training programs, such as HIIT and HIIT-KB, would present negative ARs. However, Jung *et al.* [41] showed that cycle ergometer HIIT (effort: pause ratio of 1:1 at 100% peak power; total duration 20 min) provided more positive ARs than high-intensity continuous exercise (~80% power peak; total duration 20 min). Furthermore, studies that compared HIIT ARs with MICT ones indicate that an effort: pause ratio of ≥ 1:1 can provide more positive ARs for HIIT because intervals during HIIT can decrease the feeling of discomfort and fatigue [19,41,42]. In addition, evidence has shown that traditional HIIT protocols (treadmill/cycle ergometer) that adopt a duration of exercise stimuli of 30-60s (avoiding stimuli ≥ 120s) may favor more positive ARs. In the present study, a 1:1 effort: pause ratio was used, lasting 30s, which may have favored acute positive ARs. Still, the alternation of exercises with kettlebell (i.e., swing and squat) adopted in the present study may also have contributed to the reduction of fatigue and discomfort and impacted the observed results [24,43].

Furthermore, the chronic ARs observed in the present study were also positive. It is known that the progressive increase of the load along the training period can provide more positive ARs [44,45]. During the present study, there was a progressive increase of ~126% in kettlebell weight when comparing the beginning and end of the program (8-18kg). Individual characteristics of the participants were considered to increase the load (number of repetitions, RPE ≤ 5, and execution technique). This may have contributed to the positive ARs observed over the ten training weeks without impairing adherence to the training program (~90%). This is an important factor since, for people with low levels of PA, the progressive increase in workload in a supervised training program can contribute to the maintenance of positive ARs as the workload increases and impacts future engagement with PE [46].

The present study demonstrated that it is possible to maintain positive ARs during a HIIT-KB program. Thus, kettlebell training, even applied in short duration sessions (< 30 min) with high intensities (87-90% HR_{max}), can be an exercise strategy capable of promoting acute and chronic positive ARs with a high rate of adhesion.

However, our study has the limitation of not providing information about AR measurements during exercise. It is known that the time of measurement of affect can also influence ARs to EF. The measure of affection during the exercise session has been commonly used and seems to express more negative ARs when compared to post-exercise measures [6,12]. However, studies have suggested that the measurement of affect performed during HIIT can show great variability in ARs due to the intermittent nature of interval exercise, which can make it difficult to analyze future PE behavior [45-47].

It is also noteworthy that in training protocols with many sessions (i.e., ~30 sessions), such as the one adopted in the present study, the post-exercise measures are presented as a more practical and applicable tool. Still, performing repeated measurements throughout the training program can mitigate the influence of intervening factors (e.g., changes in sleep patterns, everyday emotions, health conditions, etc.). It is suggested that future studies should compare the effects of different kettlebell training protocols in ARs during and after exercise and correlate them with other variables associated with adherence to PE, such as the intention to participate in a future session.

Conclusion

A ten-week program of high-intensity kettlebell interval training can maintain acute and chronic positive ARs even with progressively increasing kettlebell load (kg) throughout the intervention in young sedentary women.

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Conflict of interests
All authors are responsible for the content of the manuscript and approved its final version. No commercial party that supports this article and has a direct financial interest in the research results confers or will confer financial benefits on the authors or any organization with which the authors are associated. The authors declare that there are no known competing financial conflicts of interest or personal relationships that may have influenced the work reported in this article.

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Authors' contribution
Research conception and design: Nunes LB, Zimerer C, Alves SP; **Obtaining data:** Nunes LB, Zimerer C, Alves SP; **Data analysis and interpretation:** Nunes LB, Zimerer C, Alves SP, Soares ZV, Leite RD, Carletti L; **Statistical analysis:** Nunes LB, Alves SP; **Obtaining funding:** Alves SP, Zimerer C; **Manuscript writing:** Nunes LB, Zimerer C, Alves SP, Soares ZV, Leite RD, Carletti L; **Critical review of the manuscript for important intellectual content:** Nunes LB, Zimerer C, Alves SP, Soares ZV, Leite RD, Carletti L.

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