Effect of Concurrent Training Execution on Cardiorespiratory Responses During and After Exercise

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ABSTRACT

Lamego MK, Monteiro W, Lima T, Moura AMS, Soares PPS. Effect of Concurrent Training Execution on Cardiorespiratory Responses During and After Exercise. JEPonline 2018;21(1):62-75. The purpose of this study was to determine, by means of isocaloric series of aerobic exercise, the influence of different concurrent training (CT) sequences exercises on cardiorespiratory responses during and after training sessions. Ten men (age, 27.8 ± 5.80 yrs) performed 2 CT sessions, aerobic exercise + resistance exercise (AE + RE) and resistance exercise + aerobic exercise (RE + AE) in counterbalanced order. Each subject underwent a cardiopulmonary exercise test using a treadmill and a 12 maximum repetitions test (12 RM). The AE was set at the speed corresponding to 70% VO₂ reserve (VO₂R) at an incline of 1%. RE was prescribed at 80% to 12 repetitions maximum (RM). Two-way ANOVA for repeated measures after sessions showed no intergroup difference for excessive post-exercise oxygen consumption (EPOC) (P=0.64), systolic
blood pressure (SBP) (P=0.67), and diastolic blood pressure (DBP) (P=0.84). The paired t-test showed a difference in total energy expenditure (467 ± 24.9 kcal for AE + RE vs. 453 ± 30.9 kcal for RE + AE, P<0.01), but the duration of the AE + RE session was significantly longer (33 ± 2 min AE + RE vs. 28 ± 3 min RE + AE, P<0.01). These data suggest that alternating the order of AE and RE in a CT has no influence on EPOC and post-exercise hypotension (PEH), but when the AE was preceded by RE, less time was needed to obtain the same caloric expenditure. In this case, when the session was preceded by resistance exercises, less time was needed to obtain the calorie expenditure determined in the aerobic session.

**Key Words:** Concurrent Training, Isocaloric Exercise, Oxygen Consumption, Post-Exercise Hypotension

**INTRODUCTION**

Physical inactivity is considered one of the primary risk factors for the development of cardiovascular and metabolic diseases (14,21). On the other hand, regular aerobic exercise (AE) and resistance exercise (RE) have been recommended for different populations, given the positive effects in promoting health (1). Adopting these two types of training in a single exercise session is known as concurrent training (CT) (15,30), and the effects of altering the order of these activities in the session have not been fully clarified (2,22,30) when prescribing weight reduction exercises (9,20).

In addition to the calories burned during an activity, another important indicator that may lead to weight loss is excessive post-exercise oxygen consumption (EPOC) (6,12). The behavior of this indicator after engaging in AE and RE, performed separately, has been widely described in the literature (3-5,28). However, oxygen consumption responses during and after CT sessions remain scarce (2,9,17,20).

One of the aspects that needs to be elucidated is the quantification of AE volume when it is controlled by calorie expenditure in the CT session. In general, the authors consider only the duration of the activity (22, 30). However, the prescribed order of AE and RE in a CT session may affect calorie expenditure of the second activity. Another aspect that may be affected by the order of activity prescription in CT sessions is post-exercise hypotension (PEH) (11,23). However, when calorie expenditure is used to quantify the volume of work in the aerobic portion of the CT session, there are no studies investigating the influence of this strategy on EPOC.

Although some studies have assessed the effects of concurrent exercises on EPOC (9,22, 30) and PEH (11,18,29), none have controlled the volume of aerobic activity of a CT session by energy expenditure. Controlling the activity by the isocaloric method has the advantage of applying the same volume to the aerobic exercise, irrespective of the order of its execution during the session. Thus, the present study assessed the influence of alternating the order of AE and RE in the CT session on EPOC and PEH. Moreover, we compared oxygen consumption during the AE session when conducted before and after resistance training in the CT session.
METHODS

Subjects
Ten healthy men volunteered to take part in this study. To do so, the individuals had to have answered “no” to all questions on the Physical Activity Readiness Questionnaire (PAR-Q) and given their informed consent. All the individuals were physically active, and engaged in aerobic and resistance exercises at least 2 times·wk$^{-1}$ for 6 months. This study was approved by the institutional Salgado de Oliveira University Ethics Committee with the number 065. The following inclusion criteria were established: (a) not engaged in any competitive sports; (b) not involved in other aerobic or strength activities during the study; (c) have at least 6 months of experience in resistance training; and (d) familiar with the exercises and equipment used in the RE sessions. During the study, the subjects were instructed as follows: (a) use clothing and shoes consistent with the sport; (b) not ingest alcoholic beverages and/or stimulants (coffee, chocolate, teas, etc.) up to 24 hrs before the tests; and (c) not engage in intense physical activities such as running, long walks, weight training up to 48 hrs before the tests. The following exclusion criteria were adopted: (a) use of medication and/or ergogenic substances that could alter cardiovascular responses; (b) osteomyoarticular disorders that may hindered engaging in the proposed exercises; (c) history or presence of cardiovascular problems; and (e) resting systolic blood pressure $\geq$140 mmHg and/or diastolic blood pressure $\geq$90 mmHg.

Procedures
The study was developed in two phases (Figure 1). In the first phase, which lasted 5 d, 48 hrs apart, the volunteers were familiarized with the resistance and treadmill exercises. The following were determined: (a) blood pressure (BP), heart rate (HR); (b) oxygen consumption (VO$_2$) at rest; (c) morphological characterization of the sample (weight, height, and estimated fat percentage); (d) cardiopulmonary exercise test; and (e) 12 reps maximum (RM) test in the exercises proposed. The second phase consisted of 2 d of data collection, 48 hrs apart. The subjects performed two sessions of concurrent exercises, in which the order of activity execution was alternated. In one of the sessions, the subjects conducted RE followed by AE and in the other, the order was reversed. For each subject, the order of execution of the first activity was alternated in a counterbalanced design.

Figure 1. Flowchart of the Study.
Cardiopulmonary Exercise Test
To determine the intensity of the AE, the subjects underwent a maximum cardiopulmonary treadmill test using an individualized ramp protocol. The test was designed to last an average of 10 min, varying between 8 and 12 min, with a constant load increment ratio until the end of the test. The subjects’ gas and ventilatory exchanges were measured using a computerized ergospirometric analysis system (V02000 MedicalGraphics®, Medical Graphics Corp. USA). Heart rate (HR) was monitored by a Polar RS800 heart rate monitor. Guidelines proposed by Silva et al. (7) were used to establish the ramp protocol.

Calibration procedures were in accordance with the manufacturer’s instructions. Ambient temperature and humidity varied between 20° and 25° C and 40% and 65%, respectively. For the test to be considered maximum, the subjects had to exhibit at least three of the following criteria: (a) maximum self-reported exhaustion; (b) HR ≥90% of age-predicted maximum HR (220-age) or no rise in HR with an increased load at the end of the test; (c) VO\textsubscript{2} plateau with increased exercise intensity at the end of the test; (d) respiratory exchange ratio >1.1; and (e) Borg scale score ≥9 (CR-10).

Twelve Repetitions Maximum Strength Testing
The load of 12 RM was determined for the peck deck, unilateral squat, bent over row, leg press, bicep curls, and lying down triceps extension. All the bars and plates were weighed on a high-precision scale. To minimize possible errors in obtaining a load equivalent to 12 R, the following strategies were adopted: (a) all the subjects received standard instructions on the general data assessment routine and the exercise technique for each exercise before the test; (b) the exercise technique during all the test sessions was monitored and corrected, if necessary; and (c) all the subjects received encouragement during the test. All tests were performed in the morning.

Before each test, the subjects warmed up with 10 reps at a comfortable load. A maximum of three attempts was allowed for each exercise, with a 5-min interval between them. After obtaining the load of a given exercise, a 10-min interval was given to obtain the load of the next exercise. To define the load, the angular amplitude of all the exercises was maintained, neither exceeding nor diminishing these movements.

Experimental Protocol
The study took place in a climatically controlled laboratory on two separate occasions. The VO\textsubscript{2} was collected for 15 min at rest in the supine position, disregarding the first 5 min. The order of activity execution at the CT sessions was counterbalanced (AE + RE and RE + AE). A 10-min interval was given between the first and second activity. All the measures were taken by a same investigator. The interval between the two CT sessions was 48 hrs and the subjects were instructed not to engage in physical activities during the study period.

Aerobic Exercise
The AE was initiated with a warm-up consisting of a 3-min walk at a speed of 5.0 km·h\textsuperscript{-1} with an inclination of 1%. After this period, the velocity was adjusted to 70% of the velocity of VO\textsubscript{2}R with a 1% inclination until the subject obtained an energy expenditure of 300 kcal. Calorie expenditure was calculated after the warm-up, based on VO\textsubscript{2} values obtained by a metabolic analyzer (VO2000 MedGraphics®, Medical Graphics Corp. USA) with output data
frequency of 20 sec. After achieving energy expenditure of 300 kcal, the subjects cooled down for 5 min at 5.0 km·h⁻¹ at an inclination of 1%.

**Resistance Exercise**
The RE session was consisted of six exercises in the following order: (a) peck deck (taurus multi-pec); (b) unilateral squat, HBM; (c) bent over barbell row, HBM; (d) leg press (Righetto high on); (e) elbow flexion (standing bicep curls), HBM; and (f) elbow extension (lying down triceps extension) in dorsal decubitus, HBM. The order of the exercises was established to alternate segments, starting with the large muscle groups.

The subjects performed three series of 12 reps with 2 min between series and 3 min between exercises. The exercises were executed at 80% of 12 RM. Subjects were instructed to exhale in the concentric phase and inhale in the eccentric phase. Calorie expenditure during the session was calculated based on VO₂ values obtained by the metabolic analyzer (VO2000 MedGraphics®, Medical GraphicsCorp. USA) with output data frequency of 20 sec. When resistance training was the first activity of the session, it began with a 3-min warm-up at 5.0 km·h⁻¹ and a 1% inclination. When resistance training was the second activity of the CT session, there was no warm-up since the subjects had engaged in a prior aerobic activity.

**Measures After Exercise**
Two minutes after the conclusion of exercise protocols, EPOC and PEH were measured for 30 min in the supine position under a controlled environment. Blood pressure was checked by the same assessor on the right arm, 5 min apart for a total of 7 measurements. With respect to EPOC, VO₂ was measured using a VO2000 gas analyzer (MedGraphics®, Medical GraphicsCorp. USA) that was calibrated according to the manufacturer’s recommendations and a pneumotachograph (2 to 30 L·min⁻¹). Measures were taken every 20 sec.

**Statistical Analyses**
All the results are presented as mean ± standard deviation. The t-test for paired samples was conducted to determine possible differences in time and total energy expenditure in the sessions. To assess the effects of the two treatments on the categorical variable (group) and dependent variable (phases), two-way repeated measures ANOVA was performed (AE + RE and RE + AE). The Tukey’s post hoc test was applied to determine specific differences. Statistical analyses were carried out using SPSS 20.0 statistical package. The significance level of P<0.05 was used for all analyses.

**RESULTS**
Table 1 shows the characteristics of the sample while Table 2 presents oxygen consumption (mean ± SD) in the pre-exercise situations and during the AE and RE sessions at different CT. Both orders increased the responses of VO₂ of the subsequent session (P<0.05).
Table 1. Age, Anthropometric, and Cardiovascular Characteristics of the Sample.

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (yrs)</strong></td>
<td>27 ± 5</td>
<td>21</td>
<td>36</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>81.1 ± 15.0</td>
<td>59.8</td>
<td>100.9</td>
</tr>
<tr>
<td><strong>Height (cm)</strong></td>
<td>175 ± 9</td>
<td>157</td>
<td>189</td>
</tr>
<tr>
<td><strong>BMI (kg·m⁻²)</strong></td>
<td>26 ± 3</td>
<td>20.9</td>
<td>29.8</td>
</tr>
<tr>
<td><strong>BFP (%)</strong></td>
<td>14 ± 4</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td><strong>VO₂ rest (mL·kg⁻¹·min⁻¹)</strong></td>
<td>3.1 ± 1.1</td>
<td>2.0</td>
<td>5.6</td>
</tr>
<tr>
<td><strong>VO₂ peak (mL·kg⁻¹·min⁻¹)</strong></td>
<td>37 ± 4</td>
<td>30.2</td>
<td>44.5</td>
</tr>
<tr>
<td><strong>HR rest (beats·min⁻¹)</strong></td>
<td>61 ± 7</td>
<td>43</td>
<td>72</td>
</tr>
<tr>
<td><strong>HR peak (beats·min⁻¹)</strong></td>
<td>187 ± 7</td>
<td>173</td>
<td>201</td>
</tr>
<tr>
<td><strong>SBP rest (mmHg)</strong></td>
<td>115 ± 6</td>
<td>98</td>
<td>122</td>
</tr>
<tr>
<td><strong>DBP rest (mmHg)</strong></td>
<td>74 ± 6</td>
<td>60</td>
<td>80</td>
</tr>
</tbody>
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SD = Standard Deviation; BMI = Body Mass Index; BFP = Body Fat Percentage; VO₂ = oxygen consumption; HR = Heart Rate; SBP = Sistolic Blood Pressure; DBP = Diastolic Blood Pressure

Table 2. VO₂ Behavior (Mean ± SD) Before, During, and After the Concurrent Exercise Sessions.

<table>
<thead>
<tr>
<th></th>
<th>PE</th>
<th>AE</th>
<th>RE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AE + RE (mL·kg⁻¹·min⁻¹)</strong></td>
<td>2.8 ± 0.6</td>
<td>24.11 ± 3.3</td>
<td>8.56 ± 1.68*</td>
</tr>
<tr>
<td><strong>RE + AE (mL·kg⁻¹·min⁻¹)</strong></td>
<td>2.9 ± 0.3</td>
<td>26.57 ± 3.3³</td>
<td>7.8 ± 1.39</td>
</tr>
</tbody>
</table>

PE = Pré-Exercise; AE = Aerobic Exercise; RE = Resistance Exercise; ³ = P<0.05 vs. AE + RE; * = P<0.05 vs. RE + AE

Figure 2 illustrates the EPOC data obtained in the different concurrent sessions. No significant difference (P=0.64) was detected between the two concurrent sessions over a 30-min period. In the post-exercise situation, differences were observed during the first 10 minutes of monitoring (P<0.05) of the two concurrent sessions in relation to the pre-exercise.
From the 10th-min post-exercise onward, none of the sessions showed any difference compared to pre-exercise (11 to 20 min post-exercise vs. pre-exercise, \( P = 0.09 \); 20 to 30 min post-exercise vs. pre-situation, \( P = 0.85 \)). A difference was found in the EPOC values obtained between 11 and 20 min and 21 to 30 min, respectively, in relation to 0 to 10 min (\( P < 0.05 \)).

![Graph](image)

**Figure 2. Excess of Post-Exercise Oxygen Consumption (EPOC) in Relation to Pre-Exercise Situation.** Values are mean ± SD; * = difference in relation to pre-exercise data; + = difference in relation to data obtained between 0 and 10 min for both groups.

Figure 3 presents SBP behavior in the CT sessions. No difference in SBP was found (\( P = 0.67 \)) when the CT order was changed. On the other hand, a difference was identified between the pre-exercise values and some of the post-exercise moments.

![Graph](image)

**Figure 3. Sistolic Blood Pressure Behavior in the CT Sessions.**

Figure 4 presents the subjects' DBP behavior in the CT sessions. No differences were observed between the two CT orders (\( P = 0.84 \)) in the different situations assessed.
DISCUSSION

The purpose of this study was to compare cardiorespiratory responses during and after concurrent training sessions. The following results were found: (a) there was no difference in the EPOC between the concurrent training modes; (b) calorie expenditure in the AE + RE mode of exercise was greater than the RE + AE mode of exercise; (c) on the other hand, RE + AE showed less total aerobic session time in achieving the calorie expenditure expected in the isocalorie session; and (d) alternating the order of activities in the concurrent session did not affect post-exercise blood pressure. These data confirm the initial hypotheses of this study, given that previous aerobic or resistance exercise increases the oxygen consumption ($V_O^2$) of the following exercise mode. Since our objectives focused on two main points, $V_O^2$ and post-exercise blood pressure, the discussion will address these physiological responses.

Post-Exercise Oxygen Consumption and Calorie Expenditure

The acute effects of concurrent training on $V_O^2$ during and after an exercise session are scarcely reported in the literature (2,9,17,22,30). Of the studies performed, only one did not use a treadmill for AE. Studying 10 males, Drummond et al. (9) demonstrated that the order of exercise execution in a concurrent session influenced EPOC when the RE was performed at the end of the session. Their data contradict the findings in the present study, where EPOC showed no difference between the two modes of CT. However, the aforementioned study found an increase in $V_O^2$ during aerobic exercise conducted after RE, when compared to the same exercise performed before resistance exercises. Even though the RE protocols were similar in the two studies, AE differed in intensity and work volume. Whereas the subjects exercised at 70% $V_O^2$ max for 25 min in the study by Drummond et al. (9), in the present study the subjects exercised at a velocity corresponding to 70% of $V_O^2$R, until reaching calorie expenditure equivalent to 300 kcal. Irrespective of the order of exercise execution in the concurrent session, in our study the duration of AE was always greater than that of the aforementioned study.
Vilacxa et al. (30) also compared VO$_2$ responses during and after different combinations of RE and AE. With 8 young subjects in a concurrent session, their RE protocol consisted of 6 exercises (4 performed with 3 series of 10 reps and 2 with 3 series of 20 to 30 reps). The AE was executed using interval training on an exercise bicycle for 20 min. There was no difference in EPOC between the different orders of exercise execution in the concurrent session, corroborating the study in question. However, there were no differences in VO$_2$ responses when AE was executed before and after RE, which contradicts our experiment where a difference in VO$_2$ was found during AE when performed at different orders of execution in the concurrent session.

In another study, Kang et al. (17) investigated VO$_2$ behavior in young women in an AE session performed separately and another session where AE was executed after RE. They found higher VO$_2$ values for the same exercise intensity and duration when it was preceded by RE. These findings corroborate those of the present study, highlighting the fact that, even though a stationary bicycle was used the RE session had an influence on the VO$_2$ values obtained during an AE session.

It is important to underscore that in the present study both sessions resulted in an increase in VO$_2$ in the subsequent session. In other words, the AE session also resulted an increase in VO$_2$ during the resistance exercise session, in relation to the same session when performed before AE. Thus, since the aerobic exercise session was isocaloric (300 kcal), the individuals reached this value in a significantly shorter time when executed after the resistance exercise session (28 ± 3 min. vs. 33 ± 2 min). The total calorie expenditure of this session was lower (467 ± 24.9 kcal AE + RE vs. 453 ± 30.9 kcal RE + AE). However, even though this difference was significant, it is important to underscore that the session that generated 14 fewer kcal was on average 5 min shorter. In other words, in the RE + AE session, if the individuals remained in the aerobic activity to achieve the same aerobic activity executed before the resistance exercise session, the total calorie expenditure of this session would be higher. This being the case, with respect to practical applicability, if an individual intends to execute CT where the volume of the AE session is a fixed time, which is commonly used, the AE + RE session will likely result in greater calorie expenditure.

Drummond et al. (9) showed that the AE session did not influence the subjects’ HR responses and perceived effort during the RE session, when compared to RE conducted before the AE session. Thus, a gap in this experimente was not to have compared oxygen consumption responses in the resistance exercise session, which is a limitation that the present study sought to correct.

As to the order of execution of the exercises in EPOC, Oliveira and Oliveira (22) compared its magnitude and duration after 2 exercise sessions with different orders of execution in young men. Aerobic exercise was performed for 30 min on a treadmill (80% to 85% of the subjects’ heart rate reserve (HRR)) and the RE protocol consisted of 5 exercises that were executed with 3 series of 10 reps. Their findings are in agreement with the present study, where no difference was recorded in the magnitude of EPOC between the two CT execution modes. An aspect that may have contributed to the comparable findings in the two studies is the similarity between aerobic and resistance exercise protocols used. Even though the aerobic session in the aforementioned study was not quantified based on calorie expenditure, the
duration of the effort was similar to that used in the present study. Moreover, both studies used a treadmill to perform aerobic exercises.

Finally, Di Blasio et al. (2) compared cardiorespiratory responses after the TC sessions in untrained women. The AE were executed on a treadmill at 60% of HRR ± 5 beats·min⁻¹, while the RE consisted of 8 exercises executed in 3 series with a 2-min interval between them. In this case, as in our study, changing the order of the activities in the concurrent session did not affect EPOC. These data, in conjunction with data from the other studies mentioned above, reinforce the premise that the execution order of activities does not have a decisive influence on EPOC behavior after CT. However, due to the similarity between most AE and RE protocols in CT, future studies should investigate the effect of different volumes and exercise intensities in post-CT EPOC.

**Post-Exercise Blood Pressure**

A number of studies have suggested that aerobic and resistance exercises cause a drop in blood pressure in the post-exercise recovery period (8,10,26,31). With respect to health promotion, it is recommended that these two types of exercise be combined in a single training session (1). On the other hand, the wide variation in methodological aspects that determine the prescription of these exercises may lead to PEH with different magnitudes and duration (16,19). Our study appears to be the first to investigate the effect of isocaloric sessions of aerobic training, executed in different orders in C sessions, on PEH. In the CT sessions with AE calorie expenditure programmed for 300 kcal, varying the execution sequence of activities caused PEH with no difference in magnitude.

Our results partially corroborate those of other investigations (18,27,29), given that we found a lowering of BP after CT. However, with respect to duration and/or magnitude of reduction, the present study obtained different results from the other studies. Teixeira et al. (29), for example, investigated cardiovascular responses for 120 min after CT, AE, and RE. The CT protocol consisted of 30 min of AE at 75% of VO₂ peak on a stationary bicycle that was followed by 6 exercises with 3 series of 20 reps at 50% of 1 rep maximum (1RM), lasting approximately 30 min. The CT was programmed to last twice as long as the AE and RE separately. Among the findings was a reduction in SBP, when compared to base levels, with a difference in favor of AE from 90 min until the end of monitoring. These authors suggest that RE may have decreased the hypotensor effect of AE in the concurrent session. However, our data do not corroborate this hypothesis since SBP did not vary with the order of exercise execution in the concurrent session.

In a similar study, Ruiz et al. (27) compared cardiovascular responses after separate sessions of AE, RE, and 1 session of CT. The CT, composed of RE followed by AE, obtained a larger volume than the separate protocols. The RE consisted of 3 series of 12 RM with 8 exercises aimed at the major muscle groups; whereas, in AE the subjects exercised for 40 min on a stationary bicycle at 60 to 70% of VO₂R. During the entire post-exercise phase (60 min), all the exercise sessions exhibited PEH, but at 30 minutes, SBP was lower with AE than RE. In a similar study, Keese et al. (18) submitted their subjects to 3 exercise sessions, one with AE (50 min on a stationary bicycle at 65% of VO₂ peak), another with RE (3 series of 8 reps with 80% of 1 RM in 8 exercises) and CT. In this last case, one series was removed from RE and 20 min from AE. All sessions were programmed to last ~60 min. The main
finding was that the magnitude of PEH was similar in the 3 exercise sessions, but it lasted longer after AE, followed by CT and RE, respectively.

In light of the data obtained in studies that monitored hypotension post-CT, including the present investigation, which varied the order of activities in the session, the presence of RE, irrespective of their order in the session, may be able to reduce the hypotensor effects of RE. A number of central and peripheral mechanisms could explain this phenomenon, although these aspects were not assessed here. After AE, the central factors responsible for reducing cardiac output (CO), combined with the peripheral mechanisms that act in decreasing peripheral vascular resistance (PVR), may lower blood pressure more than other types of exercise. On the other hand, PEH resulting from RE seems to involve central mechanisms with a concomitant reduction in CO and systolic volume (SV) due to greater sequential compression of the blood vessels (13). In concurrent training, mechanisms similar to those used in RE are recommended, since they are able to attenuate PEH compared to AE and are more effective than RE performed separately.

In regard to the magnitude and duration of PEH in the present study, the position that individuals adopted during recovery (supine) may have contributed to increasing CO, which was compensated at certain moments by the reduced PVR during the 25-min recovery period. In the supine position, the volume of blood tends to be transferred to the upper body. This favors venous return to the heart and stimulates the baroreceptors to increase cardiac filling and SV. In a sitting position, as was the case in the other studies, blood is transferred to regions below the heart level, hindering venous return due to the absence of the skeletal muscle pump. In this situation, CO tends to decrease due to the reduced SV, even with a concomitant increase in the subjects' HR (25). Although these mechanisms may contribute to understanding the use of methodological aspects more favorable to PEH, further studies should be conducted to confirm these promising possibilities.

CONCLUSIONS

In light of the data obtained, it can be concluded that alternating the order of aerobic and resistance activities in a concurrent session has no influence on EPOC and PEH. However, the order of aerobic activity had a direct effect on the time required to obtain the expected calorie expenditure. In this case, when the session was preceded by resistance exercises, less time was needed to obtain the calorie expenditure determined in the aerobic session. In an applied perspective, when the aim is to obtain greater total calorie expenditure, it would be pertinent to initiate it with resistance exercises. This information might be useful for planning concurrent exercise sessions in individuals that need more weight control and/or weight loss.

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