Perceptual and Affective Responses of Different Muscle Actions during Weight Training in Older Women


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ABSTRACT

Ferreira SS, Alves RC, Benites ML, Soave JL, Silva AC, Ribeiro KAT, Krinski K, DaSilva SG. Perceptual and Affective Responses of Different Muscle Actions during Weight Training in Older Women. JEPonline 2013;16(6):79-88. This study investigated the perceptual and affective responses of different muscle actions during weight training in older women. Fourteen women between 60 and 75 yrs of age participated in this research. All subjects completed four exercise sessions. During the first session, maximum strength was determined (1RM) in the following exercises: lying supine, leg extension, front pulley, leg curl, and side lifting. In the second, third and fourth exercise sessions, concentric (CONC), eccentric (ECC), and dynamic (DYN) training were randomly performed. Rating of perceived exertion (RPE) and affective responses were determined after each series of exercises. To analyze RPE and affective responses between the exercises during the same training session, ANOVA with repeated measures was used with a significance level of P≤0.05. No significant effects were found for perceptual and affective responses between sessions with different muscle actions. Regarding exercises during the sessions, significant effects were found for RPE (F (4,52) = 6.272, P=0.003, $\eta^2_p = 0.325$) only between exercises: supine x pulley (P=0.007) and leg extension x pulley (P=0.004) in ECC. The RPE and affective responses were similar between the different muscle actions. However, the ECC exercise sessions promoted better perceptual and affective responses (depending on the exercises used).

Key Words: Aging; RPE; Affective Responses; Resistance Exercises
INTRODUCTION

Aging promotes physiological changes that lead to progressive mobility disability that increases the risk of falls. The result is a negative influence on functional capacity and, consequently, a decrease in the elderly's independence (6,8). In particular, the loss of the neuromuscular function is considered one of the main physiological factors associated with aging (7). Due to the decrease in muscle protein synthesis and anabolic hormones, muscle becomes smaller and weaker. Mitochondrial dysfunction, poor nutrition, changes in neuromuscular innervation, and physical inactivity contribute to sarcopenia (16,24). These factors influence the decrease in basal metabolic rate, which increases the percent of body fat and the onset of diseases (7,24).

In an attempt to find ways to fight the effects of aging, exercise physiologists have used weight training as a way to prevent or improve the performance of the neuromuscular system (25). A regular program of weight training promotes improvement in muscular endurance, balance, coordination, and functional ability, which helps to improve health and longevity (2,9,23).

To maximize the positive effects that result from improving the neuromuscular system, different types of resistance training have been studied (18,21). Reeves and colleagues (27) assigned their subjects to conventional resistance training sessions performing both concentric and eccentric contractions and to eccentric-only resistance training sessions. They concluded that the two training regimens resulted in differential adaptations in muscle architecture and strength. In agreement, Miller et al. (25) indicated that the types of muscle actions can promote different physiological, perceptual, and affective responses. Although the physiological benefits of eccentric, concentric, or dynamic activity for different age groups are well documented, there is relatively little information about the perceptual and affective responses.

This thinking is supported by the work of Bellezza et al. (4) who examined the influence of exercise order on blood lactate, perceptual, and affective responses to resistance exercise in 20-year-olds. Here again, there is little analysis of the same variables in the elderly. Thus the purpose of this study was to determine the perceptual and affective responses of different muscle actions during resistance training in older women.

METHODS

Subjects

Fourteen women with no experience in weight training were recruited for this study. Each subject gave written consent. The experimental design was classified as pre-experimental (32), which was approved by the Ethics Committee in Research of the Department of Health Sciences, Federal University of Parana - Brazil.

The criteria for participation in the study included the following: (a) subject’s age between 60 to 75 yrs old; (b) enabling conditions for the regular practice of physical exercise; (c) negative responses on all items of the Revised Readiness Physical Activity Questionnaire (rPAR–Q); (d) body mass index (BMI) between 18.5 and 30; and (e) self-report of no history of smoking for at least 12 months.

Anthropometric Measurements

The subjects’ stature (cm; Sanny stadiometer™, São Paulo, Brazil) and body mass (kg; Toledo scale™, São Paulo, Brazil) were measured according to the techniques described by Gordon et al. (15). The body mass index (kg·m⁻²) was calculated as body weight divided by height squared. Body density (in g·ml⁻¹) was determined using the skinfold thickness method, according to the equation...
proposed by Durnin and Womersley (10) for women. Percentage of body fat (BF%) was determined by the Siri’s equation (30).

**Perceptual, Affective, and Perception of Activation Measurements**

Perceived exertion was determined using the scale of OMNI-RES (28), which is essentially a Likert scale of 10 points with anchors ranging from 0 ("extremely easy") to 10 ("extremely difficult").

Affection was measured using a Hardy and Rejeski scale of sensation (17) that consisted of a 11-point scale with unique items: bipolar, ranging from +5 ("very good") and -5 ("very bad") with zero considered neutral. According to Van Landuyit et al. (33), the scale of sensation presents correlation coefficients ranging from r = 0.41 to 0.59 with the affection scale by Russell et al. (29).

The Felt Arousal Scale (FAS) was used to measure the perception of activation (31). The scale consists of six activation levels that ranged from low activation ("1") to high arousal ("6"). Previous FAS research (33) reported a correlation between 0.5 and 0.70 with the Self-Assessment Manikin scale and between 0.47 and 0.65 with the Affect Grid.

**Familiarization Session**

The subjects’ familiarization took place during two sessions. In the first session, anthropometric measurements were performed (weight, height, and body fat percentage). In the second session, all subjects were familiarized with the correct execution of the movements required of the equipment (lying supine, leg extension, front pulley, leg curl, and side lift). Standardized instructions on the scales of perceived exertion, affection, and activation were given before and during familiarization on the equipments.

**Procedures**

All subjects completed four exercise sessions. In the first session, the maximum force of the exercises was determined in the following order: lying supine, leg extension (extensor), front pulley, leg curl, and side lifting. The 1RM was used to test the subjects, which is in agreement with ACSM to evaluate the maximum force in adult and elderly subjects (1,2,14).

Maximum force was determined according to the procedures proposed by Fatouros et al. (13). The subjects were instructed to lift the weight only once. If the subject made more than one repetition, the load would be increased and another attempt would be made after 3 min of rest. The same procedure was repeated until the subject failed to lift the load with the proper technique. The last load used in carrying out the proper technique of motion was recorded as the 1RM. Each subject was encouraged to lift additional loads to ensure that the peak force was reached. A washout period was used between 5 min of workout.

In the second, third, and fourth exercise sessions, concentric (CONC) training, eccentric (ECC) training, and dynamic (DYN) training were randomly performed. Each exercise session was performed according to the ACSM position on progression models in resistance training for elderly subjects. In this guideline, it is recommended that older adults perform single joint and multi-joint exercises, free weights, and machines based on 3 sets of 8-10 repetitions each, with a moderate load of 50-70% 1RM (1,2,14). All exercises were performed on machines with the exception of side lifting, which required free weights.

Each training session was classified as: (a) DYN exercise training session (70% 1RM); (b) CON training session (70% 1RM); and (c) ECC training session (90% 1RM). The ECC session was based on the findings of Hortobagyi and Katch (19) that suggested the ECC training should be greater than
20% CON 1RM (i.e., 70% + 20%). The speed of muscle actions was controlled through verbal communications by the assessor so that the subject kept up a cadence in the concentric and eccentric stages of 2:2 seconds according to the procedures of Kramer and Ratamess (22). The rest interval between sets was 2 min to improve strength and muscle hypertrophy. The same time was established to transition from one exercise to another to allow the subjects to move to the apparatus, adjust the load, and position themselves correctly.

The scales of RPE, affective valence, and perceived activation were presented during the rest interval between sets. The order of presentation of the scales was randomly performed. The execution of the exercises in the sessions DYN, CONC, and ECC followed the same order held at 1RM test. In each exercise, the subjects performed 10 repetitions with the help of two evaluators who allowed them to perform eccentric and concentric actions alone. The interval between the sessions established a minimum of 48 hrs and 96 hrs from each other.

**Statistical Analysis**

Descriptive statistics (average ± SD) were used for the characterization of the data. To analyze the perceptual, affective, and activation responses between exercises during the same training session, a 3 x 5 ANOVA with repeated measures was used, training (DYN, CONC, and ECC) x order of exercises (bench press, leg extensor, flexor, pulled, and side lifting). The main effects and interactions were analyzed using the post-hoc Bonferroni test. When there was the presence of violations of the assumptions of sphericity, the Greenhouse-Geisser correction was applied. The magnitude of effect was calculated using the partial eta squared (η^2_p). The level of significance for the analysis was P≤0.05. The data were statistically analyzed using the computer program SPSS (version 17.0).

**RESULTS**

The corresponding values for age, anthropometric measurements, 70% of 1RM (DYN, CONC), and 90% of 1RM (ECC) are shown in Table 1 as mean ± SD.

**Table 1. Anthropometric Variables, 1RM Test, and Training Loads.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean ± SD</th>
<th>Variables</th>
<th>1RM</th>
<th>70%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>68.5 ± 4.6</td>
<td>Supine (kg)</td>
<td>22.23 ± 6.2</td>
<td>16.7 ± 5.6</td>
<td>21.1 ± 7.2</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>63.0 ± 12.0</td>
<td>Leg Extension (kg)</td>
<td>59.62 ± 14.7</td>
<td>40.8 ± 9.5</td>
<td>51.5 ± 12.2</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>154 ± 0.06</td>
<td>Pulley (kg)</td>
<td>35.85 ± 6.6</td>
<td>25.4 ± 4.5</td>
<td>32.3 ± 5.8</td>
</tr>
<tr>
<td>BMI (kg·m⁻²)</td>
<td>26.1 ± 3.5</td>
<td>Leg Curl (kg)</td>
<td>23.31 ± 9.6</td>
<td>17.2 ± 6.7</td>
<td>20.8 ± 7.5</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>35.2 ± 5.0</td>
<td>Side Lift (kg)</td>
<td>4.08 ± 0.7</td>
<td>2.7 ± 0.6</td>
<td>3.2 ± 0.7</td>
</tr>
</tbody>
</table>

BMI = body mass index; Data are expressed as average ±SD.

Figure 1 shows the perceptual and affective responses during each exercise session. For perceptual responses, there were no significant effects for RPE between sessions with different muscle actions (F (2,26) = 0.413, P = 0.666, η^2_p = 0.031). In relation to the exercises during the sessions, significant
effects were found ($F_{(4,52)} = 6.272$, $P = 0.003$, $n^2_p = 0.325$) only between lying supine x pulley ($P = 0.007$) and leg extensor x pulley ($P = 0.004$) in ECC. There was no interaction of the RPE training and exercises during the training sessions ($F_{(4.270, 55.506)} = 1.693$, $P = 0.161$, $n^2_p = 0.115$).

Figure 1. Perceptual Responses of Weight Training vs. Different Exercises.  
Significant differences: (*) Supine x Pulley; ($) Leg Extension x Pulley.

Regarding the affective responses (Figure 2), there were no significant effects between sessions with different muscle actions ($F_{(2,26)} = 2.403$, $P = 0.110$, $n^2_p = 0.156$) during the exercises of the same session ($F_{(4,52)} = 3.096$, $P = 0.102$, $n^2_p = 0.192$), and interaction of affect between training and exercises ($F_{(8, 104)} = 1.055$, $P = 0.401$, $n^2_p = 0.075$).

Figure 2. Affective Responses of Weight Training vs. Different Exercises.
The results of activation (Figure 3) were similar to affective responses with no significant effects between sessions with different muscle actions ($F_{(2,26)} = 2.153, P = 0.136, n^2_p = 0.142$) during the exercises of the same session ($F_{(4,52)} = 2.844, P = 0.116, n^2_p = 0.179$), and interaction between the activation training exercises ($F_{(8,104)} = 0.817, P = 0.589, n^2_p = 0.059$).

**Figure 3.** Responses of the Activation Perception of Weight Training vs. Different Exercises.

**DISCUSSION**

The perceptual and affective responses observed in acute exercise sessions have been shown to be an important initial strategy in the anticipation of additional research (4,5). Previous findings regarding the behavior of RPE and affective responses during different types of exercise sessions help to encourage the general public to engage in the health benefits of regular exercise (3). Thus, the purpose of this study was to investigate the perceptual and affective responses of different muscle actions during resistance training in older women in order to better understand anaerobic exercise and the promotion of healthcare benefits.

As to the subjects’ perceived responses, there were no statistically significant differences between the different exercise training sessions. Interestingly, the findings are in agreement with Hollander and colleagues (18) who reported that the RPE responses of young subjects were not different between the concentric and eccentric exercises. However, our findings disagree with Miller et al. (25) in a similar study that found RPE was lower during the ECC exercise than in the activities of CONC and DYN.

Specifically, with regards to the elderly, Hortobagyi and Devita (20) and Overend et al. (26) observed that the isokinetic eccentric exercise had lower RPE than the concentric action. Although most
studies show smaller responses of RPE in eccentric action, the methodological differences and sample presented in the literature make critical and rigorous comparisons difficult.

Unlike general responses between training sessions, significant differences in RPE between the exercises were found only for ECC session. The exercise pulley had the lowest perceived responses, which differed from the supine and extensor exercises (Figure 1). Similar responses were found in the Reeves and colleagues’ (27) investigation. In their study, lower perceived responses were obtained for the eccentric action in the leg press exercise with no significant differences between the dynamic and eccentric knee extension exercises.

In retrospect, it seems reasonable to conclude that the higher absolute load developed in the ECC exercise session (i.e., 90%) and the characteristic of the required muscular action in the exercise pulley served to contribute significantly to the lower RPE. However, to know for sure, it is necessary that additional research is carried out to better understand the influence of these considerations on RPE.

Regarding affective responses (Figure 2), the exercises performed in reverse RPE, demonstrating higher responses of affect where there was less RPE. This behavior is consistent with a review study by Ekkekakis and colleagues (11) that highlights the existence of an inverse relationship between exercise intensity and affective responses. However, significant differences were not found during and between workouts. For Ekkekakis et al. (12) perceptual responses can be explained using the sense of activation during exercises and yet, similar to the affect, changes in activation (Figure 3) during exercise were not found. In a similar study, Miller et al. (25) did not observe differences in affect between muscle actions in young women. Despite the methodological variations in the studies, preliminary investigations are in agreement with the results found in this study.

CONCLUSION

This study found that the perceptual and affective responses were similar between the different muscle actions. Differences were found in the subjects’ RPE response only in the eccentric exercise pulley session. Therefore, it appears that ECC exercise promotes better perceptual and affective responses in the elderly subjects when beginning a regular exercise program. Clearly, though, there is the need for more research to verify whether the characteristics of the exercises in weight training influence one or more perceptual and affective responses to training.

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