Is the Self-Selected Resistance Exercise Intensity by Older Women Consistent With the American College of Sports Medicine Guidelines to Improve Muscular Fitness?

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Abstract

Elsangedy, HM, Krause, MP, Krinski, K, Alves, RC, Hsin Nery Chao, C, and da Silva, SG. Is the self-selected resistance exercise intensity by older women consistent with the American College of Sports Medicine guidelines to improve muscular fitness? J Strength Cond Res 27(7): 1877–1884, 2013—The purpose of this study was to verify the self-selected intensity during resistance training (RT) in older women. Twenty healthy women (mean age, 65.6 years) underwent a 2-week familiarization period followed by 3 experimental sessions. During the first session, anthropometric measurements were taken. The second session involved completion of a 1 repetition maximum (1RM) test for the following exercises: chest press, leg press, lat pull-down, leg extension, lateral shoulder raise, leg curl, biceps curl, and triceps pushdown. Last, a single RT session was performed at a self-selected intensity. During the RT session, participants were instructed to self-select a load for performing 3 sets of 10–15 repetitions. Data were analyzed by mean (SD) and analysis of variance with repeated measures (p < 0.05). Global mean of the 3 sets was bench press 41.0%, biceps curl 48.0% 1RM (15.5), and triceps pushdown 51.7% 1RM (13.3); there were no significant differences between the sets (p > 0.05). These results indicate that inactive older women self-selected an intensity exercise during RT below the recommendation for improvements on muscle fitness in apparently healthy older adults. However, this intensity is recommended for very deconditioned individuals. Nevertheless, the use of self-selection strategy during an exercise program can have greater advantages because of its easy applicability, its positive relation with exercise adherence, and for promoting initial muscle conditioning in older adults. Furthermore, it is crucial to gradually increase the RT load to guarantee better and sustainable effects on muscle fitness. Finally, future studies are needed to establish the chronic effects of RT at self-selected intensity on muscle fitness and the functional health of older adults.

Key Words elderly, strength exercise, exercise prescription

Introduction

Resistance training (RT) is a type of exercise that has increased its popularity among older adults (aged 65+) because of its benefits on muscle fitness, mobility, and prevention of sarcopenia, which is considered one of the main factors that is responsible for reducing functional capacity in older adults (3,37). The American College of Sports Medicine (ACSM) recommends that older adults perform RT at least 2 days per week. This should include 8–10 exercises involving the major muscle groups at moderate intensity (5–6 on a scale of 0–10, equivalent to 50–69% 1 repetition maximum [1RM]) or vigorous intensity (7–8 on a scale of 0–10, equivalent to 70–84% 1RM) (3). In addition, very deconditioned older adults could initiate RT with a “very light” to “light” intensity (40–50% 1RM) to increase strength and power and improve balance (16).

Conventional approaches to exercise prescriptions have been broadly applied to older individuals who are seeking health benefits and in many interventional studies conducted with this cohort (3,23,27,36). The main health benefits from RT were based on a traditional exercise regimen that prescribed type, frequency, duration, and intensity of the program. Recent investigations have shown a direct...
relationship between exercise intensity and noncompliance (4,8–10,25,28). This is further supported by the ACSM, which in 2006 noted that adherence is lower among higher intensity programs. Additionally, Pollock proposed that people participate in programs they enjoy and that lower intensity effort makes programs more enjoyable (30). Furthermore, the prescription of exercise intensity, particularly among sedentary individuals, may not be consistent with the individual’s preference (26). Differences between prescribed and self-selected exercise intensity lead to a reduction in an individual’s sense of autonomy, decreases feelings of enjoyment, and limits the perception of exercise as a pleasure-related activity (11,14). Together, these factors negatively influence exercise adherence and psychological well-being (11,14).

Dishman et al. (9) suggest that there is a natural trend for participants to deviate from the prescribed intensity toward a self-selected exercise intensity. Furthermore, previous investigations have demonstrated that allowing individuals to self-regulate their exercise intensity to a preferred intensity is one method that leads to greater enjoyment of the exercise session, promotes a positive memory of the exercise experience, and may ultimately play a significant role in predicting exercise adherence (9,12,13,19,20,39,40). Additionally, these studies demonstrated that during aerobic exercise, the self-selected intensity approximated or exceeded the minimum level of the range recommended by the ACSM (16).

To the best of our knowledge, no studies have investigated a nontraditional form of exercise program in older adults, in which the participant could self-select the load during RT instead of using a previously prescribed intensity (11,14). Studies have indicated that self-selected intensity during RT by young adult women is below the recommended values for improvements in muscle fitness (17,32). Despite positive implications of the self-selected intensity strategy on exercise adherence, only a few studies have investigated whether this strategy meets the recommended guidelines to improve muscle fitness (15,17). Furthermore, these investigations were conducted only with young adults (17,32). For this reason, the purpose of this study was to verify whether the self-selected intensity by older women during RT achieves the recommended intensity range to improve muscle fitness.

**METHODS**

**Experimental Approach to the Problem**

The study consisted of a 2-week familiarization period followed by 3 experimental sessions, each separated by at least 48 hours. During the first session, anthropometric measurements were evaluated according to the procedures of Gordon et al. (18). During the second session, the maximal load test (1RM) was performed. Last, subjects undertook a single RT session at a self-selected load using the following exercises: bench press, leg press, lat pulldown, leg extension, lateral shoulder raise, leg curl, biceps curl, and triceps pushdown. Subjects were instructed to abstain from vigorous physical activity and to avoid caffeinated products and alcohol 24 hours before the experimental session (1). All sessions were conducted with subjects wearing athletic apparel and sneakers.

**Subjects**

A convenience sample of 20 nonsmoking older women (age, 60–70 years; mean age = 65.6 years; SD = 3.3 years) (Table 1) were recruited for this study. All subjects were classified as inactive and without RT experience. Subjects were recruited using radio and printed media advertisements in public places. A physician cleared all potential subjects, classifying them as apparently healthy, based on no previous diagnosis of cardiovascular, metabolic, and orthopedic disease or any other contraindications as determined by a medical history and Physical Activity Readiness questionnaires. Exclusion criteria included 1 or more positive responses on the Physical Activity Readiness questionnaire, body mass index (BMI) < 18.5 kg m⁻² or BMI > 30.0 kg m⁻². The Federal University of Parana Institutional Review Board approved the experimental protocol (CEP/SD: 1085012.11.03–CAAE: 0014.0.091.000-11).

**Procedures**

A 2-week familiarization period was completed. In the following weeks, 3 experimental sessions were carried out on different days with minimum of a 48-hour interval between sessions.

During the familiarization period, subjects learned correct execution and proper form for the prescribed exercises, mainly regarding the appropriate posture, utilization of

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<th>Table 1. Sample characteristics.†‡</th>
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†BMI = body mass index; 1RM = 1 repetition maximum.‡Upper- and lower-body strength levels were calculated using the following equation: weight pushed divided by body weight. One repetition maximum for chest press was used to estimate upper-body strength (ratio: mean 0.48 and SD 0.09), and 1RM for leg press was used to estimate lower-body strength (ratio: mean 1.01 and SD 0.24). According to ACSM normative scores, the upper-body strength is equivalent of 60th percentile and 50th percentile for lower body, age, and gender matched.
constant range of motion, and movement speed. Furthermore, in each visit, the subjects experienced different exercise intensities (low, moderate, and high) based on ratings of the perceived exertion OMNI-Resistance Exercise scale (0–10), to all the previously mentioned exercises. The purpose of this session was to familiarize the subjects with experimental procedures and to facilitate the estimation of initial loads and subsequent increments on 1RM tests. All subjects were supervised by an experienced fitness instructor while performing each exercise, which was executed as a single set of 10–15 repetitions with the minimal load available by the equipment (or dumbbells for lateral shoulder raise).

During the first experimental session, anthropometric measurements of body mass and height and BMI was calculated (data are shown in Table 1).

During the second experimental session, the 1RM test was conducted individually and supervised by at least 3 experienced fitness instructors. The 1RM was determined as the maximum resistance lifted once by repeat process to momentary muscular failure (i.e., they cannot continue) or to volitional fatigue (i.e., they do not wish to continue).

Briefly, the procedures regarding the 1RM test were warm-up on a treadmill (5-minute walking); before each test, there was a specific warm-up for each exercise with constant range of motion and without external load consisting of approximately 10 repetitions; then subjects had a 5-minute recovery interval; and the 1RM should be accomplished in a maximum of 4 attempts, in which the load was gradually increased according to individual capacity. Each 1RM test began at a weight near the expected maximum by the subjects. After the participant had about 5 minutes of passive rest to feel recovered from the previous attempt, the weight was then increased to be somewhat more difficult (varying according to the exercise performed) (29). Successive attempts with progressive loads were applied, until the 1RM value was found for each exercise. No subject required more than 3 attempts. There was a recovery period of 5 minutes between each trial until subjects achieved their 1RM and also before initiating these procedures to determine the 1RM in the remaining exercises (22). A previous study demonstrated that 2 minutes of rest between attempts has been shown to be adequate for phosphocreatine replenishment in both young and old subjects over repeated sets of exercise (34). Before the 1RM test, subjects were instructed to perform the movement during 2 seconds (1 second during the eccentric phase and 1 second during the concentric phase) (2).

To minimize the cumulative effect of fatigue, the stipulations concerning the amount of attempts executed and recovery interval were determined. Furthermore, upper- and lower-body exercises were alternated; larger muscle groups and multijoint exercises were performed before the smaller muscle groups and single joint exercise (2).

To determine the muscle fitness level of the subjects, upper- and lower-body strength ratio was calculated and compared with the ACSM normative scores (2). The results from the bench press exercise were used to estimate the upper-body strength level, which indicated that subjects were within the 60th percentile or on average for their age and gender (ratio: mean = 0.48; SD = 0.09). A similar result was found for lower-body strength, which was estimated by the leg press exercise, and indicated that subjects were within the 50th percentile or on average for their age and gender (ratio: mean = 1.01; SD = 0.24). Therefore, these results classified that upper- and lower-body strength levels are on average (24).

Resistance Training Session at Self-selected Load

This study used a common protocol that is often used in resistance exercise programs. Eight exercises comprised the exercise session, using primarily multijoint movements. Additionally, the exercise order of alternating upper- and lower-body exercises was chosen to allow greater recovery between exercises (3). Exercises were performed on machine-based resistance equipment (dumbbells were used only for lateral shoulder raise) in the following sequence: (a) bench (chest) press: subjects assumed a supine position on a flat bench, grasping the bar with a closed pronated grip (slightly wider than shoulder width), and then moving the bar off the supports placing it over the chest with the elbows fully extended lowering the bar in direction of the chest (nipple level) and returning to the beginning position; (b) leg press: subjects sat down in the machine and pressed their backs firmly against the back pad, placing the feet flat on the platform hip width apart, pushing the platform by extending the hips and knees to a fully extended position and returning to the beginning position; (c) lat pull-down: subjects sat facing the machine, grasping the bar (attached by an upper cable pulley in the equipment) with a closed pronated grip and then pulling the bar downward toward the upper chest level and returning to the beginning position; (d) Leg (knee) extension: subjects sat down in the machine and pressed their backs firmly against the back pad, placing their ankles behind and in contact with the foot roller pad (grasping the handles on the sides of the seat), raising the roller pad by fully extending the knees and returning to the beginning position; (e) lateral shoulder raise: subjects stood erect with feet shoulder width apart, knees slightly flexed, and arms hanging next to the body, holding dumbbells in each hand and performing the arms movement until the horizontal shoulder level and returning to the original position; (f) leg (knee) curl: subjects assumed a prone position on the machine, pressed the hips and torso firmly against the pads, placing the ankles behind and in contact with the foot roller pad, raising the roller pad by fully flexing the knees and returning to the beginning position; (g) biceps curl: subjects sat in the machine, grasping the bar (attached by a lower cable pulley in the equipment) with a closed supinated grip, and then moving the bar upward and returning to the beginning position; and (h) triceps pushdown: subjects stood erect.
in front of the machine, grasping the bar (attached by an upper cable pulley in the equipment) with a closed pronated grip and then pushing the bar down and returning to the original position, according to recommendations of the National Strength and Conditioning Association (21).

All participants received standard directions regarding the self-selection process: "select a load for performing three sets of 10–15 repetitions of the (exercise name)." Subsequently, subjects performed a few practice repetitions (1–2 repetitions) to gauge the load. This procedure could be repeated once or twice in case the subjects reported that the load was either too light or too heavy. Thereafter, subjects completed the exercise set with the appropriate load. Before initiating the second and third sets, participants were allowed to adjust the load. The exercise instructor never provided information about the load that could influence the subject’s selection (32).

The recovery period between each exercise was 3 minutes, with 1 minute between sets. The rationality for these recovery periods is based on previous investigations, which reported that performance of an individual may be compromised when the recovery period is short (30 seconds to 2 minutes), and longer intervals (3–5 minutes) promote a better performance on muscle strength (31). Hence, it was speculated that these intervals should be sufficient to prevent fatigue and would not compromise the execution of the remainder of the exercises and sets.

**Statistical Analyses**

Absolute values obtained from the maximal load tests (1RM) (Table 1) were used to calculate the percent of 1 repetition maximum relative to the self-selected load during the experimental RT session. Data are expressed as mean and SD. A 1-way analysis of variance with repeated measures was used to compare absolute and relative load selected between the 3 exercise sets. Significance level was set a priori as \( p \leq 0.05 \).

**RESULTS**

Table 1 shows sample characteristics consisting of descriptive and anthropometric information and absolute values of the 1RM test. Based on average BMI value, the sample was classified as overweight. The 1RM absolute values of bench and leg press exercises were used to calculate muscle fitness level of the participants, which corresponded to average scores when matched for their age and gender.

Table 2 shows absolute load values (kilograms) selected during the experimental RT session. Analysis of variance with repeated measures indicated no significant differences of these values between exercise sets, regardless of the exercise performed \( (p > 0.05) \).

Table 3 shows the relative load values (percent of 1 repetition maximum) obtained from the RT session at the self-selected load. Analysis of variance with repeated measures indicated no significant differences of these values between exercise sets, independently of exercises performed \( (p > 0.05) \).

Figure 1 shows the variability of the load selected by each participant for each exercise during the RT session.
Considering the overall session mean, independent of the exercise performed, it was observed that the majority of subjects (81.3%) self-selected a load lower than that recommended for muscle strength improvements. Furthermore, this fact was observed for each exercise being 75% for bench (chest) press, 62.5% for leg press, 56.2% for lat pull-down, 93.7% for leg extension, 25.0% for lateral shoulder raise, 50.0% for leg curl, 50.0% for biceps curl, and 43.8% for triceps pushdown.

**DISCUSSION**

The present study showed that self-selected load by apparently healthy older women was approximately 42% of 1RM and corresponds to the intensity recommended for beginners and very deconditioned individuals (16). However, the level of muscle strength of this sample was classified as on average for their age and gender (3). Thus, it is reasonable to assume that participants were physically fit and could lift a greater load. Consequently, the load selected was less than that recommended for improvements to muscle strength and endurance (moderate intensity: 5–6 on a scale of 0–10, equivalent to 50–69% 1RM; vigorous intensity: 7–8 on a scale of 0–10, equivalent to 70–84% 1RM) (3).

Based on overall mean values, 18.8% of older women in this investigation performed RT at the intensity range recommended for improvements on muscle strength and endurance (50% 1RM). A more detailed analysis was made separately for each exercise (Figure 1), determining that 42.9% of the cases corresponded to the intensity recommended for improvements on muscle strength and endurance (>50% 1RM) and 23.4% of the cases at the mean level recommended for beginners and very deconditioned individuals (40–50% 1RM), suggesting that the self-selected load may depend on the exercise performed.

Additionally, when comparing the exercises performed by small vs. larger muscle groups, the mean intensity self-selected was greater for small muscle groups (mean = 50.3% 1RM; \( SD = 2.0\)%) vs. mean = 41.6% 1RM; \( SD = 5.3\% 1RM\), respectively) and the intensity was also greater for upper-body than lower-body muscle groups (mean = 47.8% 1RM; \( SD = 4.3\% 1RM\) vs. mean = 39.9% 1RM; \( SD = 5.9\% 1RM\), respectively). Previous investigations reported possible explanations for differences in the exercise intensities because of muscle group recruitment during RT (5,32,35).

Regarding the disuse theory, Daley and Spinks (5) report that skeletal muscle appears to be the most responsive in terms of adaptations to changes in chronic patterns of use. Considering that lower-body muscles may be more elicited over an individual’s lifetime, because they are necessary for mobility (such as walking or transfers), they may realize a decreased loss of strength when compared with the muscles of the upper body (5,35). Sousa et al. (35) conducted strength training in older men (mean age = 73.0 years; \( SD = 6.0\) years), demonstrating that the absolute 1RM value was inferior for upper-body exercises (mean = 159.0 kg; \( SD = 26.4\) kg) than for lower-body exercises (mean = 179.0 kg; \( SD = 27.9\) kg) at baseline, and a greater effect was found after 12 weeks of training for upper-body exercises.

Similar to our findings, Ratamess et al. (32) found that the relative self-selected intensity by young adult women (mean age = 26.6 years; \( SD = 6.4\) years) for upper-body exercises was greater than for lower-body exercises. According to the questionnaire completed by participants, such discrepancy may be related to the women’s concern about gaining muscle mass in the lower body. Participants reported that they believed RT would produce “excessive bulk” and were surprised with the load lifted during the 1RM test for 50% 1RM. A more detailed analysis was made separately for each exercise (Figure 1), determining that 42.9% of the cases corresponded to the intensity recommended for improvements on muscle strength and endurance (>50% 1RM) and 23.4% of the cases at the level recommended for beginners and very deconditioned individuals (40–50% 1RM), suggesting that the self-selected load may depend on the exercise performed.

**Figure 1.** Dispersion analysis of the self-selected intensity by participants during the RT session. Intensity range recommended is 50–85% 1RM. Dotted lines represent the mean self-selected load during the experimental session. 1RM = 1 repetition maximum; CP = chest (bench) press; LP = leg press; LPD = lat pull-down; LE = leg extension; LSR = lateral shoulder raise; LC = leg curl; BC = biceps curl; TP = triceps pushdown; %1RM = percent of 1 repetition maximum.
Self-selected Resistance Exercise Intensity

lower-body exercise. This fact could underestimate the intensity self-selected during the RT session because of the fear of gaining excessive lower-body muscle mass (21).

The self-selected intensity in this study is in agreement with previous investigations conducted with other cohorts (15,17,32). Glass and Stanton (17) verified that sedentary men (mean age = 19.5 years; SD = 1.9 years) and women (mean age = 18.7 years; SD = 1.0 years) self-selected a load of 42–57% 1RM during an RT session composed of bench (chest) press, leg press, lat pull-down, lateral shoulder raise, and biceps curl exercises. Focht (15) compared the load lifted at a self-selected and imposed RT session, finding that sedentary young adult women (mean age = 20.6 years; SD = 3.1 years) self-selected a load of 56% 1RM, significantly lower than the imposed condition (75% 1RM). These findings indicated that self-selected load by men and women is lower than the recommendations for healthy adults and consequently would not be adequate to lead to positive effects on muscle strength and endurance (3,15,17,31). So far, no studies have investigated the chronic effects of RT at a self-selected intensity in muscle fitness or functionality in young or older adults.

Conversely, Kalapotharakos (23) examined the effects of 2 prescribed intensities during RT on muscle function and functionality of older men and women (age, 60–74 years). Comparisons were made of 2 conditions: at moderate (60% 1RM) and vigorous (80% 1RM) prescribed intensities. After 12 weeks of RT, both conditions had positive effects on strength (1RM for lower body) and functionality (sit and reach test, walking speed, chair rising, and stair climbing). A greater strength effect was found among the vigorous intensity group, but both experimental groups improved all dependent variables when compared with control group (p < 0.02). As commented previously, it seems that among older adults, the greater the dose or intensity the greater the strength benefits from RT will be achieved (3,23,27,36).

Seynnes et al. (33) conducted a study with older frail adults (mean age = 81.5 years; SD = 1.4 years) with the purpose of comparing the strength gains and functional improvement between 3 groups: high-intensity (80% 1RM) and low-intensity (40% 1RM) RT and control. After 10 weeks, both high- and low-intensity groups showed better results when compared with the control group and the baseline values (p < 0.05). However, a greater benefit was found among the high-intensity group for muscle strength (p < 0.001), muscle endurance (p = 0.008), and 6-minute walking test (p = 0.01). It is noteworthy that the functional improvements regarding chair raising and stair climbing were similar between high- and low-intensity groups. In addition, the low-intensity intervention was sufficient to promote better muscle strength and endurance and walking distance in this cohort. Moreover, the greater the dose or intensity the greater were the physiologic gains and functional improvements.

Another strategy that can influence subjects to self-select a higher load and therefore maximize chronic positive effects from RT is related to the presence of supervision during the training sessions (3,23,27,32,36). As reported by Ratamess et al. (32), supervised RT at a self-selected intensity appears to influence the load selected by young adult women. They compared the intensity self-selected for leg press, chest press, leg extension, and seated row exercises in 2 conditions: with (mean age = 25.4 years; SD = 6.8 years) and without (mean age = 28.4 years; SD = 5.4 years) a fitness instructor supervision, indicating that healthy resistance-trained women under supervision self-selected a greater load (range, 43.0–57.4% 1RM) than the group without supervision (range, 38.0–48.0% 1RM).

Graber et al. (16) recommended a lower initial intensity for very deconditioned individuals and RT beginners (40–50% 1RM) until they achieve an acceptable level of muscle conditioning to increase the load gradually, ultimately reaching the recommended intensity for improvements on muscle strength and endurance. Therefore, it may be plausible among beginners and individuals with poor muscle fitness to adopt a self-selected intensity lower than that suggested by RT guidelines for healthy older adults because of uncomfortable overloading, lack of experience with weight machines, fitness centers, and other factors (16).

Evidence shows that a self-selection strategy can contribute to maintenance and development of intrinsic motivation (22,38,39) because of a greater perception of autonomy, which can lead to a pleasant experience during the activity performed (6,7,9,22,38,40). This strategy has broad applications, particularly related to the subject’s adherence to an exercise program, increasing the initial engagement. Also, it can lead to progressive improvements concerning muscle fitness until older adults achieve a sufficient level of strength to be able to perform the exercise at the recommended intensity for healthy older adults who are seeking improvements in muscle strength and endurance.

Additionally, generalization of our findings should be done cautiously because of the experimental design used in this study. A cross-sectional design was applied in this study and may be controversial compared with follow-up interventions using the self-selection strategy on muscle strength and endurance. Furthermore, frail elderly persons or individuals with more advanced age may have different responses.

Practical Applications
Our findings indicated that inactive older women self-selected an exercise intensity during RT below the recommendation for improvements on muscle fitness in apparently healthy older adults. However, this intensity is recommended for very deconditioned individuals. It seems that there is a myriad of underlying factors related to self-selection of intensity during RT. For example, the self-selected intensity may be influenced by the exercise performed or muscle group recruitment (small vs. large muscle group or upper vs. lower body). Our findings indicated that a higher relative intensity is selected for small muscle groups and upper-body exercises.
Nevertheless, the use of a self-selection strategy during an exercise program can have greater advantages because of its easy applicability, its positive relation with exercise adherence, and for promoting initial muscle conditioning in older adults. Furthermore, it is crucial to gradually overload the RT to guarantee better and sustainable effects on muscle fitness. Finally, future studies are needed with the purpose of establishing the chronic effects of RT at self-selected intensities on muscle fitness and functionality of older adults.

References


