# Regulating Explosive Resistance Training Intensity Using the Rating of Perceived Exertion

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## Abstract

Row, BS, Knutzen, KM, and Skogsberg, NJ. Regulating explosive resistance training intensity using the rating of perceived exertion. *J Strength Cond Res* 26(3): 664–671, 2012—Explosive resistance training (ERT) improves older adults' strength and power, and methods to make this form of training more accessible and useful to older adults are needed. The purpose of this study was to evaluate whether the rating of perceived exertion (RPE) scale would predict a broad range of ERT intensities on the leg press with older adults. If successful, then a load-RPE relationship could be used to regulate the intensity of training loads for ERT with older adults, allowing the elimination of maximal strength testing. Twenty-one older adults (≥65 years) with resistance training experience took part in 2 testing sessions. Session 1: Subjects performed high-velocity repetitions on the leg press for up to 9 loads (from 60 to 140% body weight) presented in quasi-randomized order, and then reported their RPE for each load. Session 2: A 1 repetition maximum (1RM) strength test was conducted. Regression analysis revealed that the average RPE across subjects for each load strongly predicted the average %1RM across subjects ($R^2 = 99.5\%$; $p < 0.001$). This allows the establishment of a load-RPE relationship for use in selecting ERT loads for older adults on the leg press. For example, high-intensity loads (70–90% 1RM) that would elicit both strength and power gains when used with ERT aligned with an RPE of 14–16. Lighter loads that may be useful for training for power, but not strength (<70% 1RM), were identified with RPE scores of 13 and lower. The load-RPE relationship may simplify the regulation of intensity of ERT with older adults on the leg press, where the exercising older adult could be guided to select loads according to their RPE.

**Key Words** muscle power, high-velocity resistance training, aging, leg press

## Introduction

Declines in muscular strength and power are related to functional limitations and physical disabilities in older adults (2,12,35,42). Muscle power has been found to be more strongly related to mobility function in older adults than strength, making it a central focus for exercise interventions (1,12,42). Muscle power in older adults is positively affected by resistance training (RT) (3,9,19,22,33), but even more so by explosive resistance training (ERT) that includes an attempt to move the load rapidly (20,29,32). Explosive resistance training using high-intensity loads (≥70% 1 repetition maximum [1RM]) improves muscle power to a greater degree than traditional (slow) RT, while resulting in equal improvements in muscle strength (5,10,41) and functional performance (5,21,31) than traditional RT at the same intensity.

Both high- and low-intensity ERT loads have been found to be useful in training older adults. High-intensity ERT (80% 1RM) improves strength to a greater degree than low intensity ERT (20 and 50% 1RM), with equal improvements in power (7). On the other hand, low-intensity (40% 1RM) ERT is more related to balance function in older adults, and low-intensity ERT (20% 1RM) resulted in more significant improvements in balance function in older adults than ERT using high-intensity loads (32).

Allowing people doing RT to self-select their own training loads could afford them a feeling of autonomy in their own RT program and eliminate the need for maximal strength tests for the purpose of regulating intensity. However, the process of individual self-selection of RT loads typically results in an *under* selection with young adults, in which the load is not heavy enough to elicit strength and power gains. Young adult subjects allowed to self-select training loads chose loads averaging less than 60% 1RM (11,17,38). The presence of a personal trainer (38) or a familiarization session (16) improves load selection, but the average loads selected still remain below 60% 1RM. Studies have not been conducted with older adults that have quantified (as %1RM) self-selected loads for RT. A self-selection of loads has been successfully used to improve strength among older adults in an RT intervention over a period of 10 months (39), but self-selection has not been evaluated for ERT.

Given that ERT at both high-intensity and low-intensity loads is useful for muscle strength, power, balance, and

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functional capacity in older adults and that self-selection of loads has limitations, there is a need for methods that allow the trainer and the exercising older adult to reliably identify the intended load for training. Typically, load selection for ERT is done with maximal strength testing (34,40) or predicted maximum strength testing (44), so that the training load can be selected as a %1RM. A simpler process for regulating ERT that could eliminate the need for 1RM testing with older adults (15) may encourage broader implementation of ERT among trainers and older adults. A potential method of simplifying the regulation of intensity for ERT will be evaluated in this study, using the rating of perceived exertion (RPE) scale (4), which when used with RT has been found to positively correlate with physiological measures of intensity, such as muscle activation during the exercise and blood lactate (28) and blood cortisol levels resulting from the exertion (30).

Rating of perceived exertion has shown promise for the purpose of regulating intensity of resistance exercise because it has been found to exhibit a reasonably stable relationship with absolute load over several sessions for young adults (24,25), and the load that corresponded with a fixed RPE increased through an RT program with older adults, concurrent with increased strength (15). The relationship between RPE and ERT has not been evaluated. If RPE is well related to ERT loads relative to the 1RM for older adults, then a load-RPE relationship could be established that would allow the prescription of ERT loads for older adults without first requiring 1RM testing. Evaluating this relationship during a single ERT session is a first step toward understanding the potential utility of a load-RPE relationship in regulating intensity during ERT for older adults.

Therefore, in an attempt to develop a simplified approach to self-selecting ERT loads, the present study investigated the hypothesis that a reliable relationship exists between RPE and relative ERT loads on the leg press exercise for older men and women experienced in RT.

## Methods

### Experimental Approach to the Problem

Because the ultimate utility of this approach would be to use RPE to select training loads without conducting a 1RM test at any point, the subjects rated leg press loads during the first testing session, before experiencing their 1RM during the second testing session. In this way, the RPE scores for the loads experienced during the first session would be based on a novel load and would not be influenced by a recent experience with a 1RM load. The subjects' RPE during ERT was recorded during the first session for loads ranging between 50 and 150% body weight (BW) on the leg press. During the second session, subjects performed a 1RM test on the leg press. During all testing sessions, the weight stack was hidden from view of the subject, so that knowledge of the load also would not influence the RPE score. The loads lifted on the first session were calculated as a percentage of the 1RM that was conducted during the second session, to represent the loads lifted as %1RM. A regression analysis was conducted to evaluate whether RPE could predict relative ERT loads (%1RM) on the leg press, to determine whether a load-RPE relationship could be constructed. Additionally, the reliability of using the RPE measure was evaluated using an intraclass correlation analysis.

### Subjects

Healthy older men and women (Table 1) were recruited from a fitness center at Western Washington University. This project was approved by the university's institutional review board, and informed consent was obtained in writing after a demonstration and explanation of the study procedures. All the participants had experience in slow RT, but none of the subjects had experience with ERT. Twenty-six subjects participated in the first session, but 2 women did not complete the study (were unwilling to return for the 1RM test), and the results from an additional 2 men who completed the study were not included in the analysis because they were unable to obtain the same lower extremity positioning on the leg press machine as the remainder of the subjects because of the excess abdominal girth. This caused these 2 male subjects to begin the leg press action in a more extended position of the hip and knee and therefore at a more advantaged muscle length, which led to 1RM values that were above 2.5 *SD*s from the mean for the men. An additional male subject was removed from the data set because he lifted substantially more during the first visit than he achieved during the 1RM test, so one load he experienced during the first visit was ultimately calculated as being 120% 1RM. Therefore, 21 subjects' results were included in the final

**Table 1.** Subject characteristics.*

| | Total ($n = 21$) | Women ($n = 9$) | Men ($n = 12$) |
|---|---|---|---|
| Age, y | 76.6 (5.5) | 76.1 (6.1) | 77.0 (5.2) |
| Height, m | 1.72 (0.91) | 1.65 (0.09)† | 1.78 (0.05)† |
| Body mass, kg | 77.7 (12.7) | 68.4 (12.5)† | 83.5 (8.5)† |
| RT experience, y | 10.5 (9.7) | 7.7 (7.1) | 12.6 (11.1) |
| | 95% CI, 6.1–14.9 | 95% CI, 2.2–13.1 | 95% CI, 5.6–19.7 |

*CI = confidence interval; RT = resistance training.
†Men were taller and had more body mass than women, $p < 0.005$.

**Table 2.** The mean %1RM (and 95% CI) within each range of loads relative to maximum strength, the number of subjects who achieved a load within this range, and the corresponding mean RPE for this load are presented.*†

| %1RM | No. subjects | Mean load within this range (%1RM) | Mean RPE for this load |
|---|---|---|---|
| 30–39% | 13 | 34.9 (*SD* 3.0) (CI, 33.1–36.8) | 8.4 (*SD* 1.9) (CI, 7.5–9.6) |
| 40–49% | 18 | 44.0 (*SD* 2.2) (CI, 42.9–45.1) | 9.2 (*SD* 2.2) (CI, 8.1–10.3) |
| 50–59% | 20 | 52.1 (*SD* 2.2) (CI, 51.1–53.4) | 10.5 (*SD* 2.2) (CI, 9.4–11.5) |
| 60–69% | 20 | 63.0 (*SD* 1.9) (CI, 62.1–63.8) | 12.5 (*SD* 1.8) (CI, 11.7–13.3) |
| 70–79% | 20 | 73.9 (*SD* 2.1) (CI, 73.0–74.9) | 14.0 (*SD* 2.5) (CI, 12.8–15.1) |
| 80–89% | 15 | 83.3 (*SD* 2.5) (CI, 81.9–84.6) | 15.7 (*SD* 2.3) (CI, 14.4–16.9) |
| 90–100% | 9 | 92.7 (*SD* 1.9) (CI, 91.2–94.2) | 17.0 (*SD* 1.2) (CI, 16.1–17.9) |

*CI = confidence interval; RPE = rating of perceived exertion; %1RM = percent 1 repetition maximum.
†If a subject achieved more than one load within a given range, only the lowest load was included in the analysis.

analysis, including both men ($n = 12$) and women ($n = 9$). Subjects' height and weight were measured, and RT experience (in years) was obtained in an interview (Table 1).

**Procedures**

In the first testing session (session 1), the subjects were instructed on how to perform the concentric component of a seated leg press exercise rapidly while avoiding locking the knees. During a familiarization phase of session 1, the subjects were trained to push a warm-up load (of 60–90% BW) as fast as they felt they safely could, without the foot plate flying away from their feet. To achieve this, the speed was gradually increased, beginning with a slow repetition and ending in 4 or 5 repetitions with the final repetition being "as fast as you safely can." The eccentric phase was always conducted slowly and under control, and a pause was included before and after the concentric phase was performed. A 1-minute rest period was provided between each set. A cable pulley seated leg press machine was used for all tests.

For subsequent testing, the loads used ranged from 50 to 150% BW but adjustments were made to ensure that the loads experienced by each subject consisted of some loads rated as light and some loads rated as very heavy loads. The load of 50% was found to be too light for some of the subjects, and 150% was too heavy for some, and so these loads were not presented to all subjects. The subject's rating for a load allowed the experimenters to understand if loads planned for the next set would be possible for the subject to lift (e.g., if the subject rated a load of 130% BW as a 19 on the Borg RPE scale, then a load of 140% BW was not attempted). Therefore, subsequent data analysis included only loads in the range of 60–140% BW, as these loads were completed by most of the subjects.

During session 1, 9 loads were tested in randomized order, with the exception that the first load was selected to be within the warm-up range (60–90% BW), so that it would not be so heavy that a subject could potentially be unable to lift it. Subjects performed 4–5 repetitions at each load presented. During the set of 4–5 repetitions, the subjects' velocity was increased with each repetition until the last couple of repetitions were conducted "as fast as safely possible" (8).

The original qualitative descriptors accompanying the Borg 6-point to 20-point RPE scale (4) were presented to the

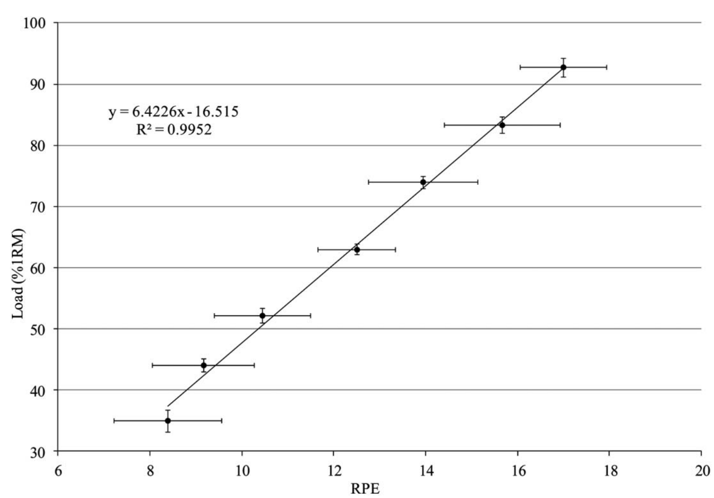


**Figure 1.** Average RPE predicted average %1RM on the leg press. Error bars reach from the lower to upper bounds of the 95% confidence interval of the mean %1RM (vertical error bars) and RPE (horizontal error bars).

**TABLE 3.** The load-RPE relationship, in which %1RM was predicted from RPE.*†

| Qualitative description | RPE | Predicted %1RM* |
|---|---|---|
| Maximal | 20 | 112 |
| Very, very hard | 19 | 106 |
| | 18 | 99 |
| Very hard | 17 | 93 |
| | 16 | 86 |
| Hard | 15 | 80 |
| | 14 | 73 |
| Somewhat hard | 13 | 67 |
| | 12 | 61 |
| Fairly light | 11 | 54 |
| | 10 | 48 |
| Very light | 9 | 41 |
| | 8 | 35 |
| Very, very light | 7 | 28 |
| | 6 | 22 |

*RPE = rating of perceived exertion; 1RM = 1 repetition maximum.
†Rounded to the nearest whole number.

subjects alongside the numerical ratings (7, very, very light; 9, very light; 11, fairly light; 13, somewhat hard; 15, hard; 17, very hard; 19, very, very hard). The subjects were further verbally oriented to the scale with the explanation that a score of 7 would represent a very, very light activity, like an "easy stroll"; a score of 17 was described as a load that would be "very challenging, but you can continue"; and a score of 20 was described as marking the "maximum effort," where he or she could do no more. Furthermore, the subjects were questioned about whether they felt that the foot plate would have flown away from their feet had they pushed as fast as they could, and these answers were recorded after the experience of each load.

To prevent prior experience with specific leg press loads from influencing the subjects' RPE at each load, the weight stack was concealed from the subjects by a curtain at all times during the study. Because of this, the subject only became aware of the magnitude of the load on lifting the first repetition of the set, which was always conducted in a slow and controlled manner with subsequent repetitions increasing in velocity. The repeatability of the RPE ratings for the loads was evaluated after the initial range of loads was completed. This was done at the end of session 1 with a second presentation of 5 of the loads the subject lifted during that session. The subjects were not informed that they would lift some loads twice but rather were instructed that they would lift a variety of loads ranging from light to heavy.

During the second session (session 2), which was at least 48 hours and at most 1 week after session 1, a 1RM leg press strength test was conducted, beginning with a warm-up load of 60–90% BW, depending on the subject's performance during session 1. The purpose of performing the 1RM was to convert the loads collected in session 1 as %BW into loads calculated as %1RM. The 1RM was conducted during session 2 so that the RPE scores for the loads experienced during session 1 would not be influenced by a recent experience with a 1RM load. The movement performed during the 1RM test was slow and controlled (i.e., ERT methods were not used for 1RM testing), in accordance with accepted 1RM methods. A 2RM was accepted in place of the 1RM if there was not a small enough increment in the weight stack to allow the subject to lift the load just once, instead of twice or not at all. This occurred with 6 subjects, and this number was recorded in place of the 1RM. An additional 6 subjects stopped the test due to being unwilling to attempt higher loads because of a concern regarding the potential for injury. The load they lifted during their last successful attempt was recorded in place of their 1RM. In each of these cases, the subjects' stated their RPE to be 19 or 20, indicating that the load was likely near their actual 1RM.

### Statistical Analyses

Each load rated during session 1 was calculated as a %1RM by dividing the load by the 1RM measured in session 2 and multiplying by 100. A regression analysis including all data points (up to 9 loads) for all subjects combined could not be conducted

**TABLE 4.** Performance variables for the subjects, including 1RM and the %BW corresponding to the 1RM.†‡

| | Women ($n = 9$) | Men ($n = 12$) | All subjects ($n = 21$) |
|---|---|---|---|
| 1RM, kg | 98.0 (*SD* 24.4)* | 135.4 (*SD* 20.4)* | 119.4 (*SD* 28.8) |
| | 95% CI, 79.2–116.7 | 95% CI, 122.4–148.4 | 95% CI, 106.3–132.5 |
| 1RM, %BW | 146.4 (*SD* 41.1) | 162.4 (*SD* 20.4) | 155.6 (*SD* 31.2) |
| | 95% CI, 114.8–178.0 | 95% CI, 149.5–175.4 | 95% CI, 141.4–169.8 |

†%BW = percent body weight; CI = confidence interval; 1RM = 1 repetition maximum.
‡There were no significant differences between men and women on any measure, except for absolute leg press 1RM (in kilograms), *$p < 0.001$.

without violating the assumption of independence that each observation is from a different subject. Therefore, for each subject, the lowest value in each 10% 1RM range (e.g., 30–39%, 40–49%, 50–59% 1RM) was included in a calculation of the average across subjects for that 10% 1RM range. The RPE accompanying that value was included in an average RPE calculation across subjects. For each 10% 1RM range, a different number of subjects were included in the calculation of the mean %1RM and RPE, according to how many subjects were able to attempt the load that fell within that range (Table 2). Furthermore, at times, subjects achieved more than one load within a 10% range, and in these instances, only the lowest load within the range was included in the analysis. Only 2 subjects included in the analysis reached a load greater than 100% 1RM during session 1: one at 103.6% and the other at 107% 1RM, and so this range of greater than 100% 1RM was not included in the analysis. A simple regression analysis was then conducted to evaluate whether the average RPE for each load predicted the average %1RM for each load between the ranges of 30 and 100% 1RM. Previous research has revealed no sex difference in RPE between sexes for RT (14), and so results from both men and women were included in the single regression analysis.

The reliability of the RPE during ERT was evaluated using the intraclass correlation coefficient of the RPE obtained from the first and second exposures of the 5 loads that were repeated during session 1.

Descriptive statistics (mean and *SD* and confidence intervals) were calculated for the 1RM (in %BW). Both absolute and relative 1RM, height, and weight, were compared between sexes using independent *t*-tests. The alpha level of significance for all tests conducted was $p \leq 0.05$.

## Results

The average RPE for each load strongly predicted the average %1RM for each load ($R^2 = 99.5\%$; $p < 0.001$; *SE* of the estimate = 1.6; Figure 1). The regression equation expressing this relationship was %1RM = (RPE × 6.423) − 16.515. Table 3 reveals the load-RPE relationship resulting from the regression equation, where the predicted %1RM (from the regression equation) is aligned with the corresponding RPE. The intraclass correlation coefficient for the RPE between the first and second exposure of the same load during session 1 was $R_I = 0.729$, indicating a moderate stability of the rating between the 2 exposures. Although previous studies have revealed nonlinear relationships between RPE and %1RM (37), the prediction equation was not improved by polynomial regression models (which, for second- and third-order models revealed an $R^2 = 99.6$ and 99.8%, respectively, but estimated that an RPE of 20 would correspond to 109.0 and 123.5% 1RM, respectively) or a power equation (which revealed an $R^2 = 98.7\%$ and estimated that an RPE of 20 would correspond to 116.3% 1RM).

The subjects participating in this study self-reported an average of more than 10 years of RT experience. Men were stronger than women in absolute strength ($p < 0.001$) and had greater height and weight ($p < 0.005$, Tables 1 and 3), but there were no sex differences in the relative 1RM (as %BW).

Subjects responded to the question: "Did you feel like the foot plate would fly off of your feet if you pushed as fast as possible?" affirmatively when experiencing loads on this cable pulley leg press machine that were less than or equal to approximately 50% 1RM, which corresponded with an RPE of less than or equal to approximately 11.

## Discussion

Borg RPE ratings were found to significantly predict loads relative to the 1RM for older adults with RT experience, resulting in the acceptance of the experimental hypothesis. The load-RPE relationship presented in this study may be useful when training older adults using ERT on the leg press. For example, commonly selected RT loads that elicit strength and power gains (≥70% 1RM, as suggested intensity for RT by Pollock et al. (37)) were identified with an RPE of ≥14 in this study using the leg press. It is important to note that the subjects' ratings were obtained before their 1RM test, so their ratings were solely based on their reflection of the perception of the load with the numbers and qualitative phrases on the Borg RPE scale and not based on a recent experience with the sensation of the loads used during a 1RM test. This makes this approach feasible for regulating ERT loads in the absence of a 1RM test in a fitness center.

The resulting load-RPE relationship seems to be reasonable for use in an RT setting; a load that would be considered high intensity (e.g., 80% 1RM) corresponds to an RPE of 15–16, corresponding to a qualitative description of "hard" on the scale. Very high–intensity loads (e.g., 90% 1RM) relate to the range of 17–18 on the RPE scale, corresponding to a qualitative description of "very hard." Loads less than 60% 1RM, and therefore less useful for improving muscle strength, align with an RPE of 11 and lower on the RPE scale, corresponding to a qualitative description of "fairly light" at the highest intensity within that range. This load-RPE relationship may represent a useful depiction of the desired perceptions for older adults during ERT of various loads, opening the door to the elimination of maximal strength testing as a means of regulating intensity during ERT. The load-RPE relationship appears to be less useful in the highest range of the scale, where a "maximal" exertion of 18–20 corresponded with a range of 99–112% 1RM, whereas the intention of the score of 20 is that it would represent 100% 1RM.

A previous study of older adults averaged the RPE for leg press and knee extension training sets over 36 sessions, reporting an RPE of 12.6 (corresponding to less than "somewhat hard" on the Borg scale) during ERT at 40% 1RM and an RPE of 15.4 (hard) during traditional (slow-paced) RT at 80% 1RM (41). As the current study is cross sectional and included only the leg press, the present results are not directly comparable to the study by Sayers (41); however, the RPE of 15.4 noted at 80% 1RM during RT in the previous study is comparable to the present study's prediction of an

RPE of 15 (hard) at 80% 1RM during ERT (Table 4). This evidence, therefore, also lends support toward the utility of the load-RPE relationship when training older adults. A study among older adults comparing the RPE using the same loads for RT and ERT has yet to be conducted. The results from the present study also relate well with previous estimates of RPE for young adults during RT on the leg press (27), where 90% 1RM was found to be 17.3, which corresponds to very hard on the Borg RPE scale. In the present study of older adults performing ERT, 90% 1RM was estimated to be approximately 17, which is also in the very hard region of the Borg RPE scale (Table 4).

The results of the present study do not conform with results obtained by Lagally et al. (27) for the lower loads, as they found a 30% 1RM load to correspond to a rating of 13.0 (somewhat hard) on the Borg RPE scale, whereas in the present study, an RPE of 13 corresponded with 67% 1RM. This difference is likely because of the previous study's methods of anchoring the low and high ends of the RPE scale to unweighted and 1RM leg press loads, respectively, as did Gearhart et al. (13), who also used the 15-point RPE scale (ranging in rating from 6 to 20) during RT with young adults on several different upper and lower extremity exercises, identifying 90% 1RM and 30% 1RM as approximately 14–15 and approximately 8–10 on the RPE scale, respectively. This process involved a detailed method of "anchoring" the low and high end of the RPE scale to the sensation of performing the lift with no load and at 1RM. The present study aimed to provide a simple and straightforward method for identifying ERT loads in a fitness center, and so a set of instructions identifying a baseline rating of 6 for the leg press with no load and a maximal rating of 20 for the 1RM, as in Gearhart et al. (13), was not used. In the present study, RPE successfully and strongly linearly predicted the %1RM for loads between 30 and 100%1RM. The more time-consuming anchoring procedures used in previous studies (13,27) appear to be unnecessary for characterizing useful ERT loads using the standard RPE scale with only a simple explanation to the people who exercise.

It is apparent that the use of a cable pulley leg press machine with a vertical weight stack is problematic for relatively light loads (≤ approximately 50% 1RM, RPE ≤ approximately 11) because the foot plate can project off of the participant's feet with a fast leg press repetition. This would mean that in periodized programs that aim to integrate ERT at lower loads, for example, approximately 40% 1RM, which are linked to postural balance performance (32), it would be safer to use other training methods than a cable pulley leg press to achieve such light loads. Many studies have used pneumatic RT machines when conducting ERT (7,8,10,31,32,41), which would be safer for light loads as the foot plate would not project from the feet; however, many older adults may have only cable pulley machines available, and so this result is important to note for ERT to be administered safely with these machines.

Several limitations can be identified that affect the applicability of these results to all older subjects. The study procedures took place in the summer season, and it is possible that increased summer physical activity rates may influence the results of this analysis (6). However, the leg press 1RM values for the subjects in the present study (Table 4) compare well with the average baseline leg press results for older adults in previous RT studies, which have ranged from 64 to 123 kg for older women (1,10,23) and 113 to 175 kg for older men (5,7,18,20,21,23). Furthermore, the present study included older adults who are accustomed to RT but who had no experience with ERT. It remains to be seen whether a similar load-RPE relationship would also exist between ERT loads and RPE for older adults with no experience in RT, but previous research revealed no difference in RPE and muscle activity between experienced and novice lifters for young adults performing bench press (26), and the authors of that study noted this finding as a support for the use of RPE to regulate exercise intensity for both experienced and inexperienced weightlifters.

It is unknown whether this study's results would also be found using different exercise machines other than the leg press. Furthermore, it is unknown whether the use of RPE to determine loads for ERT will be effective in long-term programs with older adults, although there is some evidence that RPE increases over the course of a training program along with increases in the absolute training load (43). Additionally, the regulation of RT load using constant-RPE tracking (where the RPE is used to identify a constant relative load) appears to have both promise and limitations for RT in older adults, given that RPE predicted the same %1RM after exercise for some exercises and loads, although not all (14). The usefulness of RPE through a training program, as a method of regulating the load used during ERT, is yet to be established.

Six subjects did not reach a true 1RM because they stopped the test because of their concerns regarding the potential for injury at such high loads; thus, it is unclear how far from their true 1RM these subjects were, and because the loads were represented as a percentage of the 1RM, it is uncertain how much this would have affected the RPE at each load for these subjects. These subjects' 1RM was designated as the last load they completed during the 1RM test. If this 1RM approximation was much less than the true 1RM, then each relative load would be overestimated compared with if a true (higher) 1RM had been measured (e.g., 80 kg is 67% of a 1RM of 120 kg, but if the true 1RM was 130 kg, then 80 kg would actually be 61.5% 1RM). This inflation of the relative loads for these subjects likely contributed to the overestimate of 112% 1RM at RPE = 20 in the present study. However, each of these subjects rated the last load they lifted as RPE 19 or 20, indicating that they were likely near their personal 1RM. When excluding these subjects from the analysis, an RPE of 20 estimated 104–108% 1RM for the linear and polynomial models and 111% for the power model, which is still an overestimate of the %1RM that an RPE of 20 should represent.

Although not measured, the nutritional and hydration status of the subjects were presumed to have remained unchanged, as subjects were tested within 1 week apart at about the same time of day for both session 1 and session 2, and this time typically corresponded to the subjects' preferred training time (the subjects were tested during the time they usually arrived for RT).

## Practical Applications

Explosive resistance training at both high-intensity and low intensity loads is desirable because the range of intensities improves muscle strength, power, balance, and functional capacity in different and important ways in older adults. There is a need for simplified methods for regulating ERT intensity with older adults, to make ERT more accessible for personal trainers and their older adult clients (i.e., not requiring a maximal strength test). The load-RPE relationship resulting from the present study reveals that the numbers and qualitative ratings on the standard Borg RPE scale predict relative seated leg press loads on a cable pulley RT machine. Therefore, the numbers on the scale can be used as a guide to select the intended load for ERT. For example, an RPE between 14 and 16 corresponds to loads in the range of approximately 70–90% 1RM for ERT, a stimulus that is known to significantly improve leg press strength and power simultaneously in older adults (7). Additionally, an RPE lower than 12 corresponds to loads less than approximately 60%, which is the range of ERT intensity that is related to balance function (32).

This study also revealed that loads less than or equal to approximately 50% 1RM (corresponding to less than or equal to approximately 11 on the RPE scale) are potentially problematic on a leg press cable pulley RT machine because subjects reported, during these light loads, that the leg press foot plate would have projected off of their feet had they pushed as fast as they could. The hazard of this occurring is that the foot plate would then rapidly return to the starting position, potentially injuring the client. Such light loads, therefore, should be avoided when conducting ERT on a cable pulley leg press machine. On the other hand, moderate to high loads were safely conducted using ERT methods with this population on a cable pulley leg press machine.

It is yet unknown whether the load-RPE relationship would be effective for regulating training intensity throughout the course of an ERT intervention (e.g., it remains unknown whether an RPE of 14–16 would consistently relate with a relative load of approximately 70–90% 1RM throughout an ERT program). It is also unknown whether the load-RPE relationship identified here would apply similarly to other exercises beyond the leg press.

Even before the full impact of the load-RPE relationship is understood for ERT, the present study's results can be implemented by personal trainers who aim to improve strength and power simultaneously in their older adult clients, without requiring maximal strength testing, by the following: (a) directing older clients' attention to the Borg RPE scale; (b) providing a description of the meaning of the 6- to 20-point ratings using the original accompanying qualitative descriptor words; (c) selecting a load that the client rates within the range of an RPE of 14–16, corresponding to an intensity of approximately 70–90% 1RM; and (d) training the client to increase the velocity with each repetition until it is as fast as safely possible during the concentric phase while avoiding locking the knee before the eccentric phase and conducting the eccentric phase in a slow and controlled manner.

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