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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-

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

ABLE 2. The mean %1RM (and 95% CI) within each range of loads relative to maximum strength, the number of subjec 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 = con dence 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). SubjectsÕ height and weight were measured, and RT experience (in years) was obtained in an interview (Table 1).

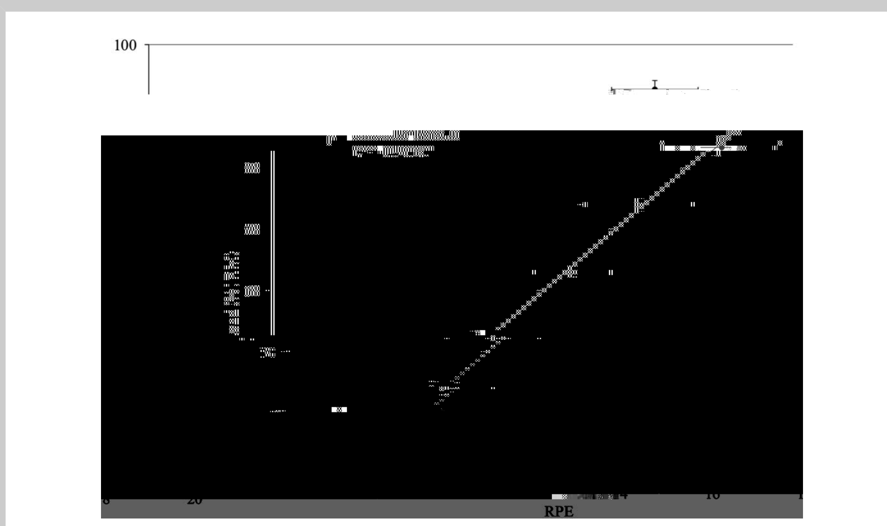
P

In the Þrst 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 60Ð90% BW) as fast as they felt they safely could, without the foot plate ßying 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 Þnal repetition being ÔÔas fast as you safely can.ÕÕ 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 subjectÕs 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 60Ð140% 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 Þrst load was selected to be within the warm-up range (60Ð90% BW), so that it would not be so heavy that a subject could potentially be unable to lift it. Subjects performed 4Ð5 repetitions at each load presented. During the set of 4Ð5 repetitions, the subjectsÕ velocity was increased with each repetition until the last couple of repetitions were conducted ÔÔas fast as safely possibleÕÕ (8).

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



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

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., 30Ð39%, 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.

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 subjectsÕ preferred training time (the subjects were tested during the time they usually arrived for RT).

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 simpliÞed 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 70Ð90% 1RM for ERT, a stimulus that is known to signiÞcantly 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 14Ð16 would consistently relate with a relative load of approximately 70Ð90% 1RM throughout an ERT program). It is also unknown whether the load-RPE relationship identiÞed 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 studyÕs 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 clientsÕ 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 14Ð16, corresponding to an intensity of approximately 70Ð90% 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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1. Bean, JF, Herman, S, Kiely, DK, Frey, IC, Leveille, SG, Fielding, Rproblem4.8(Goa

12. Foldvari, M, Clark, M, Laviolette, LC, Bernstein, MA, Kaliton, D, Castaneda, C, Pu, CT, Hausdorff, JM, Fielding, RA, and Singh, MA. Association of muscle power with functional status in community-dwelling elderly women. J Gerontol A Biol Sci Med Sci 55: M192ÐM199, 2000.

13. Gearhart, RE, Goss, FL, Lagally, KM, Jakicic, JM, Gallagher, J, and Robertson, RJ. Standardized scaling procedures for rating perceived exertion during resistance exercise. J Strength Cond Res 15: 320Ð325, 2001.

14. Gearhart, RF Jr, Lagally, KM, Riechman, SE, Andrews, RD, and Robertson, RJ. RPE at relative intensities after 12 weeks of resistance-exercise training by older adults. Percept Mot Skills 106: 893Ð903, 2008.

15. Gearhart, RF Jr, Lagally, KM, Riechman, SE, Andrews, RD, and Robertson, RJ. Strength tracking using the OMNI resistance exercise scale in older men and women. J Strength Cond Res 23: 1011Ð1015, 2009.

16. Glass, SC. Effect of a learning trial on self-selected resistance training load. J Strength Cond Res 22: 1025Ð1029, 2008.

17. Glass, SC and Stanton, DR. Self-selected resistance training intensity in novice weightlifters. J Strength Cond Res 18: 324Ð327, 2004.

18. Hagerman, FC, Walsh, SJ, Staron, RS, Hikida, RS, Gilders, RM, Murray, TF, Toma, K, and Ragg, KE. Effects of high-intensity resistance training on untrained older men. I. Strength, cardiovascular, and metabolic responses. J Gerontol A Biol Sci Med Sci 55: B336ÐB346, 2000.

19. Hakkinen, K, Kraemer, WJ, Newton, RU, and Alen, M. Changes in electromyographic activity, muscle Þbre and force production characteristics during heavy resistance/power strength training in middle-aged and older men and women. Acta Physiol Scand 171: 51Ð62, 2001.

20. Henwood, TR and Taaffe, DR. Improved physical performance in older adults undertaking a short-term programme of high-velocity resistance training. Gerontology 51: 108Ð115, 2005.

21. Henwood, TR and Taaffe, DR. Short-term resistance training and the older adult: The effect of varied programmes for the enhancement of muscle strength and functional performance. Clin Physiol Funct Imaging 26: 305Ð313, 2006.

22. Kalapotharakos, VI, Tokmakidis, SP, Smilios, I, Michalopoulos, M, Gliatis, J, and Godolias, G. Resistance training in older women: Effect on vertical jump and functional performance. J Sports Med Phys Fitness 45: 570Ð575, 2005.

23. Kosek, DJ, Kim, JS, Petrella, JK, Cross, JM, and Bamman, MM. EfÞcacy of 3 days/wk resistance training on myoÞber hypertrophy and myogenic mechanisms in young vs. older adults. J Appl Physiol 101: 531Ð544, 2006.

24. Lagally, KM and Amorose, AJ. The validity of using prior ratings of perceived exertion to regulate resistance exercise intensity. Percept Mot Skills 104: 534Ð542, 2007.

25. Lagally, KM, Amorose, AJ, and Rock, B. Selection of resistance exercise intensity using ratings of perceived exertion from the OMNI-RES. Percept Mot Skills 108: 573Ð586, 2009.

26. Lagally, KM, McCaw, ST, Young, GT, Medema, HC, and Thomas, DQ. Ratings of perceived exertion and muscle activity during the bench press exercise in recreational and novice lifters. J Strength Cond Res 18: 359Ð364, 2004.

27. Lagally, KM, Robertson, RJ, Gallagher, KI, Gearhart, R, and Goss, FL. Ratings of perceived exertion during low- and high-intensity resistance exercise by young adults. Percept Mot Skills 94(pt 1): 723Ð731, 2002.

28. Lagally, KM, Robertson, RJ, Gallagher, KI, Goss, FL, Jakicic, JM, Lephart, SM, McCaw, ST, and Goodpaster, B. Perceived exertion, electromyography, and blood lactate during acute bouts of resistance exercise. Med Sci Sports Exerc 34: 552Ð560, 2002.

29. Macaluso, A, Young, A, Gibb, KS, Rowe, DA, and De Vito, G. Cycling as a novel approach to resistance training increases muscle strength, power, and selected functional abilities in healthy older women. J Appl Physiol 95: 2544Ð2553, 2003.

30. McGuigan, MR, Egan, AD, and Foster, C. Salivary cortisol responses and perceived exertion during high intensity and low intensity bouts of resistance exercise. J Sports Sci Med 3: 8Ð15, 2004.

31. Miszko, TA, Cress, ME, Slade, JM, Covey, CJ, Agrawal, SK, and Doerr, CE. Effect of strength and power training on physical function in community-dwelling older adults. J Gerontol A Biol Sci Med Sci 58: 171Ð175, 2003.

32. Orr, R, de Vos, NJ, Singh, NA, Ross, DA, Stavrinos, TM, and Fiatarone-Singh, MA. Power training improves balance in healthy older adults. J Gerontol A Biol Sci Med Sci 61: 78Ð85, 2006.

33. Petrella, JK, Kim, JS, Tuggle, SC, and Bamman, MM. Contributions of force and velocity to improved power with progressive resistance training in young and older adults. Eur J Appl Physiol 99: 343Ð351, 2007.

34. Phillips, WT, Batterham, AM, Valenzuela, JE, and Burkett, LN. Reliability of maximal strength testing in older adults. Arch Phys Med Rehabil 85: 329Ð334, 2004.

35. Pijnappels, M, Reeves, ND, Maganaris, CN, and van Dieen, JH. Tripping without falling; lower limb strength, a limitation for balance recovery and a target for training in the elderly. J Electromyogr Kinesiol 18: 188Ð196, 2008.

36. Pincivero, DM, Coelho, AJ, and Campy, RM. Perceived exertion and maximal quadriceps femoris muscle strength during dynamic knee extension exercise in young adult males and females. Eur J Appl Physiol 89: 150Ð156, 2003.

37. Pollock, ML, Graves, JE, Swart, DL, and Lowenthal, DT. Exercise training and prescription for the elderly. South Med J