

Research article

USING SESSION RPE TO MONITOR DIFFERENT METHODS OF RESISTANCE EXERCISE

Alison D. Egan¹, Jason B. Winchester², Carl Foster³ and Michael R. McGuigan⁴✉

¹ Department of Health and Exercise Science, University of Oklahoma, USA

² Department of Kinesiology, Louisiana State University, Baton Rouge, LA, USA

³ Department of Exercise and Sports Science, University of Wisconsin-La Crosse, La Crosse, Wisconsin, USA

⁴ School of Exercise, Biomedical and Health Sciences, Edith Cowan University, Australia

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ABSTRACT

The purpose of this study was to compare session rating of perceived exertion for different resistance training techniques in the squat exercise. These techniques included traditional resistance training, super slow, and maximal power training. Fourteen college-age women (Mean \pm SD; age = 22 \pm 3 years; height = 1.68 \pm 0.07 m) completed three experimental trials in a randomized crossover design. The traditional resistance training protocol consisted of 6 sets of 6 repetitions of squats using 80% of 1-RM. The super slow protocol consisted of 6 sets of 6 repetitions using 55% of 1-RM. The maximal power protocol consisted of 6 sets of 6 repetitions using 30% of 1-RM. Rating of perceived exertion (RPE) measures were obtained following each set using Borg's CR-10 scale. In addition, a session RPE value was obtained 30 minutes following each exercise session. When comparing average RPE and session RPE, no significant difference was found. However, power training had significantly lower ($p < 0.05$) average and session RPE (4.50 \pm 1.9 and 4.5 \pm 2.1) compared to both super slow training (7.81 \pm 1.75 and 7.43 \pm 1.73) and traditional training (7.33 \pm 1.52 and 7.13 \pm 1.73). The results indicate that session RPE values are not significantly different from the more traditional methods of measuring RPE during exercise bouts. It does appear that the resistance training mode that is used results in differences in perceived exertion that does not relate directly to the loading that is used. Using session RPE provides practitioners with the same information about perceived exertion as the traditional RPE measures. Taking a single measure following a training session would appear to be much easier than using multiple measures of RPE throughout a resistance training workout. However, practitioners should also be aware that the RPE does not directly relate to the relative intensity used and appears to be dependent on the mode of resistance exercise that is used.

KEY WORDS: Weight lifting, non-traditional resistance training.

INTRODUCTION

Resistance training plays a key role in conditioning athletes for the specific strength and conditioning demands of different sports. To date, traditional resistance training has become the most widely accepted method for improving muscular strength and power (Kraemer and Ratamess, 2004).

However, traditional resistance training is but one of several techniques developed with the goal of increasing muscle mass, strength, agility, and/or power. These non-traditional methods differ from the traditional model in many ways, one of which being the different velocities at which the non-traditional methods are performed. Examples of these non-traditional methods involve manipulation

of the exercise speed including training at slow repetition speed and maximal repetition speed. Until recently, few studies have compared these two types of resistance training with the traditional method (Keogh et al., 1999). However, it is important for coaches, trainers, and even the athletes themselves to know which technique is most effective in order to design an appropriate resistance training program. A study by Keogh et al. (1999) investigated different resistance training techniques in the bench press. Alternative resistance training techniques such as heavy eccentric exercise and functional isometrics appeared to work significantly better than heavy weight training on a number of the variables including power and force production. However, methods such as super slow training and maximal power training had significantly lower levels of force than heavy weight training.

A common method used to assess the intensity of exercise is the rating of perceived exertion (RPE). This scale has been widely researched for its use in both clinical and exercise settings (Borg, 1998; Noble and Robertson, 1996). Since then the RPE scale has been validated and became a standard method of measuring the level of intensity experienced during physical activity (Noble and Robertson, 1996). Recent studies by Gearhart et al. (2001; 2002) and McGuigan et al. (2004) have yielded promising results to the scale's application of resistance exercise. A number of studies (Day et al., 2004; Foster, 1998; Foster et al. 1995; 1996; 2001; McGuigan et al., 2004) have shown that a single session RPE rating may accurately reflect the intensity of an exercise session. The previously mentioned studies investigated the use of the scale with different exercises, but did not address the scale's possible use with different resistance training techniques of the same exercise.

Of interest is how the perception of effort relates to the relative loading used for resistance exercises. Previous studies have demonstrated a relationship between the intensity of exercise as expressed as % of one repetition maximum (1-RM) and RPE (Gearhart et al., 2001; 2002; McGuigan et al., 2004). However, resistance exercise can include a myriad of variables such as number of sets, number of repetitions, velocity of movement, rest periods between sets, exercise type, equipment used etc. It would be interesting to see how manipulation of some of these acute variables would impact of perception of effort. It is well accepted that to increase power and rate of force development that explosive power training is the most effective method (Kraemer and Ratamess, 2004). There is also a large body of literature showing the intensity of exercise and adequate volume is required to

maximize muscular strength (Kraemer and Ratamess, 2004). There is also research that demonstrates clear physiological differences between high force and high power resistance training protocols, with lactate responses with higher force training (Bush et al. 1999). However, there is no clear evidence that dramatically reducing the velocity of exercises using methods such as super slow will have significant benefits for strength and power (Hunter et al., 2003, Keeler et al., 2001; Neils et al., 2005).

Therefore, the purpose of this study was to compare three different resistance training techniques in the squat exercise to examine session RPE as a tool to quantify different techniques of the same exercise. These techniques included traditional resistance training, super slow, and maximal power training.

METHODS

Experimental approach to the problem

This study used a randomized, crossover design, in which subjects completed three experimental trials in randomized. Subjects were tested at the same time of day during each of the experimental trials with no less than 48 hours between trials.

The testing schedule consisted of one familiarization session during which subjects provided informed consent to the protocol which had been approved by the university Institutional Review Board, had their height and weight measured, received instruction on the use of CR-10 RPE scale and session RPE to rate perceived exertion, performed a 1-RM test, and practiced the three types of training including traditional, super slow and jump squats. The subsequent session order was randomized for each subject and included one session of heavy resistance training, one session of super slow training, and one session of explosive resistance training. The heavy resistance training session protocol consisted of six sets of six repetitions using 80% of 1-RM. The super slow training protocol consisted of six sets of six repetitions using 55% of 1-RM. The explosive resistance training protocol consisted of six sets of six repetitions using 30% of 1-RM. These percentages were chosen based on previous recommendations that have been provided for various training protocols (Kraemer and Ratamess, 2004; Neils et al., 2005).

Subjects

Fourteen college-age women (Mean \pm SD; age = 22 \pm 3 years; height = 1.68 \pm 0.07 m; weight = 65 \pm 17 kg; squat 1-RM = 58 \pm 16 kg; squat to bodyweight

ratio = 0.85 ± 0.24) were recruited for this study. The subjects were free from any skeletal, muscle, cardiovascular, or endocrine limitations and were currently involved in a resistance-training program (of at least two sessions per week) for a minimum of 3 months. All subjects were familiar with the squat exercise and all reported having previously performed the exercise as part of their training program.

All subjects received a standardized physical examination of height, and body mass during the first phase of the study. During the duration of the study, subjects were told to refrain from exercise 48 hours prior to each testing session, to follow the same diet on each day of each trial, and not to eat for at least 3-4 hours prior to any given testing session. In addition, subjects were instructed to abstain from alcohol, caffeine, and nicotine for a minimum of 24 hours prior to any testing session.

Table 1. Rating of perceived exertion (RPE) scale. The verbal anchors have been modified slightly to reflect American English (e.g. light becomes easy; strong becomes hard). After each trial, the subject was shown the scale and asked "How would you rate your effort?" Thirty minutes post workout subjects were again shown the scale and asked, "How would you rate your entire workout?"

Rating	Descriptor
0	Rest
1	Very, Very Easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	*
7	Very Hard
8	*
9	*
10	Maximal

Testing procedures

Each subject was familiarized with the different training techniques during the initial testing session. Multiple warm-up trials were given prior to 1RM testing (% are given of subject estimated 1RM), 10 repetitions at 30% followed by 2 min rest, 7 repetitions at 50% followed by 2 min rest, 4 repetitions at 70% followed by 3 min rest, 1 repetition at 90% followed by 3 min rest. From the last warm-up set, loading was increased through subject feedback on level of repetition intensity so that 1RM was achieved within 3 trials. Four min of rest was given between each 1RM effort. For each repetition, subjects were asked to lower the bar until

their hips were parallel to their knees and were advised that upon reaching the bottom of the squat they should immediately move the bar upwards until the start position was reached. The reliability of this method of 1RM testing for the squat in our laboratory is high (ICC = 0.98).

The super slow method used 55% of 1-RM with 10 seconds for the eccentric and 10 seconds for the concentric phase while attempting to maintain constant velocity. A metronome was used to aid the subject in maintaining the correct tempo. The maximal power training used 30% of 1-RM. For the power method, subjects performed an explosive jump squat. The traditional method used 80% of 1-RM. All resistance training techniques was assessed using six sets of 6 repetitions for a total of 36 repetitions for each of the protocols. Two minutes of rest was allowed between each set. All testing was conducted using the Smith Machine.

Rating of perceived exertion measures

During the familiarization session, each subject was given instructions on the use of the RPE scale (Table 1). For assessing RPE during the exercise sessions, standard instructions and anchoring procedures were explained during the familiarization session (Borg, 1998; Noble and Robertson, 1996). Subjects were asked to use any number on the scale to rate their overall effort. A rating of 0 was to be associated with no effort (rest) and a rating of 10 was considered to be maximal effort and associated with the most stressful exercise ever performed. During each of the three training sessions RPE measures were taken after the completion of each set. Following each set during the training the subject was asked "How would you rate your effort?" The session RPE measure was used to rate the entire workout (Table 1). The subject was shown the scale 30 minutes following conclusion of the training bout and asked, "How was your workout?"

Statistical analysis

Statistical significance was set at $p \leq 0.05$. Comparisons among the groups were made using one-way analysis of variance (ANOVA). The Turkey post-hoc test was used to identify significant differences in group means.

RESULTS

When comparing average RPE and session RPE, no significant difference was seen (Figure 1). Power training had significantly lower average and session RPE (4.9 ± 1.9 and 4.50 ± 2.1) compared to both super slow training (7.81 ± 1.75 and 7.43 ± 1.73) and traditional training (7.33 ± 1.52 and $7.13 \pm$

1.73). Figure 2 shows the set by set growth of RPE during all three types of lifts. The super slow and traditional exercise bouts clearly required near maximal exertion by the last set.

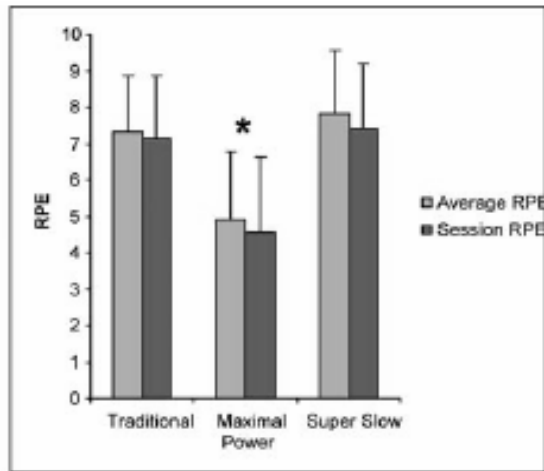


Figure 1. Average and Session RPE values (Mean ± SD) for traditional, maximal power and super slow training sessions. * indicates that the maximal power RPE was significantly less than the traditional and super slow.

DISCUSSION

The purpose of this study was to compare three different resistance training techniques (traditional, super slow and power) in the squat exercise. We found the super slow and traditional resistance training methods were perceived as being significantly harder than the maximal power method. There was no significant difference between the mean RPE measures taken following each set and the session RPE for each training method.

There are several possible reasons to explain why super slow and traditional training were perceived to be more difficult compared to the maximal power method. Firstly a greater volume of work was performed during the super slow and traditional training compared to the maximal power method. A previous study by Kraemer et al. (1993) showed that increased training volume did not necessarily relate to increases in RPE and factors such as absolute load and rest periods between sets were more important factors. Another possibility is the issue of fatigue. Since the super slow and traditional methods took longer to complete one set it is possible that subjects were more fatigued than with the maximal power training. Both traditional and ballistic squats allow some contribution via SSC to the movement. That could contribute to why super slow training seems harder in addition to the other areas mentioned. It should also be noted that the exercises were performed on a Smith Machine which would remove the balance factors associated with free weight exercises.

The loading for both the super slow and traditional training was far greater than the maximal power method. It has been previously demonstrated that when muscles are under heavy loads there is greater tension development which requires an increase in motor unit recruitment and firing frequency (Gearhart et al. 2001; Noble and Robertson, 1996). With greater motor unit recruitment, the motor cortex may send stronger signals to the sensory cortex, which may increase perceived effort (Gearhart et al. 2002). Since the super slow and traditional loads were heavier loads (55% and 80% of 1-RM, respectively) it is likely that this may partially explain the significant difference in perceived effort.

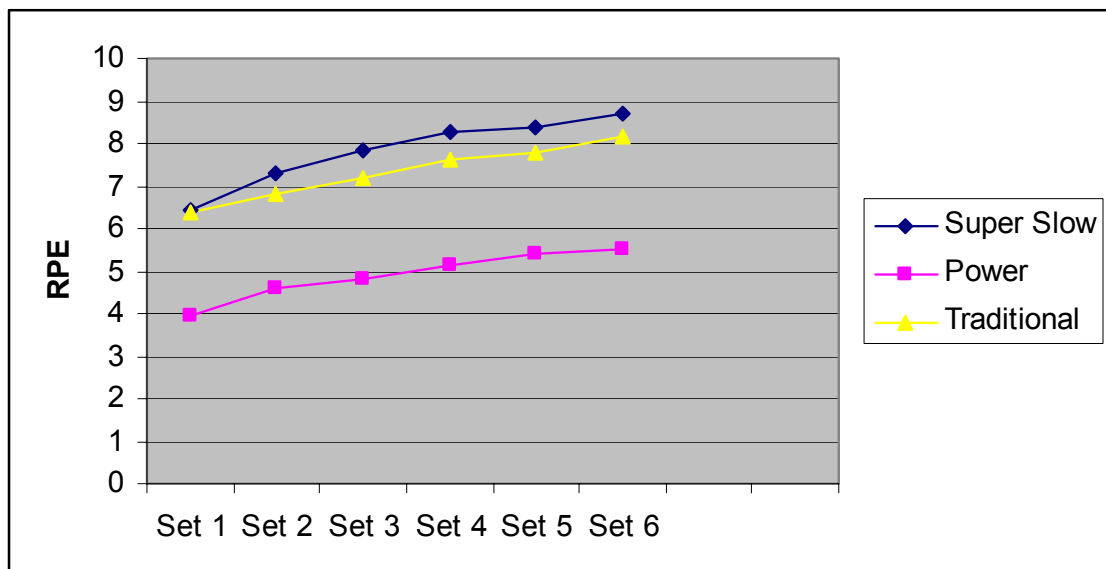


Figure 2. Average RPE values for each set for traditional, maximal power and super slow training sessions.

The finding that subjects perceived the super slow session (55%1RM) to be as difficult as traditional session (80%1RM) is an interesting one. By decreasing the speed at which a person lifts weights, it has been proposed that less friction is placed on joints and the time under tension is longer in the muscle, therefore producing greater benefits compared to traditional resistance training (Hutchins, 1993). However there is only limited research on super slow training and very little evidence for the superiority of this method over traditional resistance exercise (Hunter et al., 2003; Keeler et al., 2001; Neils et al., 2005). A previous study by Keogh et al. (1999) used similar loading with the bench press exercise. Findings by Keogh et al. (1999) indicated non-traditional resistance training techniques appeared to work significantly better than heavy weight training on a number of the variables including power and force production. . In that study, the time under tension in the super slow exercise was clearly greater than the other methods involved (such as functional isometrics and heavy weight training). The loading used for the super slow session required the subjects to lift 55% of their 1RM for six repetitions, which is similar to what has been used in previous studies (Neils et al., 2005). The lifting speed was closely monitored by the researchers and a metronome was used to monitor the lifting speed. Once the loading was increased past 55%, difficulty in lifting was experienced which limited how much loading could be placed on the body. Although the time under tension appeared to be greater with the super slow protocol it is very likely that the neurological mechanisms are different to the heavier loads used with the traditional heavier protocol with regards to motor unit recruitment. For example data from Bush et al. (1999) demonstrated that there is increased lactate per set with loads of at least 80%1-RM and this may have been a factor given the high volume of sets used in the present study (6 sets).

It is important to note that there appears to be an apparent disconnect between the perception of effort and the actual load being used in the super slow method. There needs to be a reduction in loading to make it possible to complete the required number of repetitions. Although this results in greater time under tension with lighter loads due to asynchronous motor unit recruitment, the subjects appeared to perceive this type of loading to be as difficult as the heavier traditional training. This may have also been exacerbated in the subjects in this study, who although they had 3 months of resistance exercise experience, did not report having used super slow methods previously. As there are no randomized controlled trials demonstrating strength

and power benefits for super slow training, the efficacy of this type of training needs to be questioned. This highlights the need for practitioners to be aware of the limitations of relying solely of a subject's perception of effort to assess the effectiveness of a training intervention.

It is possible that the relatively short duty cycle in the power exercises, with at least a small unloaded time during the flight phase of the jumps led to improved blood flow, and contributed to the lower perceived exertion. We (Foster 1999), have previously demonstrated that several markers of fatigue, including muscle oxygen saturation and blood lactate accumulation, are greater during speed skating in the circumstances were higher muscle forces and a long duty cycle contribute to reductions in muscle blood flow. It is probable that with all three protocols the muscle forces were high enough to limit muscle blood flow. However, with the pattern of exercise in the super slow and power exercise, it seems reasonable to speculate that the relatively longer and shorter periods of increased muscle tension, respectively, may have contributed to the increased sensation of effort.

In the present study, RPE values for each set were taken in addition to the session rating. The main purpose of taking the RPE values following each set, in addition to comparing average and session RPE, was to further familiarize the subjects with rating their perceived effort on the RPE scale. We believed this would increase the accuracy of the session RPE value. We did not find any significant difference between the session RPE and the average RPE values. The lack of significant difference between the RPE measures and the session RPE confirm findings from previous studies (Day et al., 2004; McGuigan et al., 2004; Sweet et al., 2004). Additionally, Foster et al. (2001), who examined session RPE as a tool for quantifying aerobic exercise, found high correlation between the average RPE and session RPE values using regression analysis. This provides further evidence that session RPE is a valid tool across a variety of modes of training. Lastly, Eston et al. (2006) have recently demonstrated that the growth of RPE during the course of fatiguing exercise appears to follow scalar properties, with a predictable RPE at various percentages of the relative maximal effort. This relationship is apparently stable even when the performance ability is experimentally manipulated by a preceding exercise bout. Thus, RPE in its various manifestations may provide a remarkably accurate, if simple, window into the metabolic disturbances associated with different types of exercise.

CONCLUSION

It appears that the resistance training mode that is used results in differences in perceived exertion that does not relate directly to the loading that is used. Using session RPE provides practitioners with the same information about perceived exertion as the traditional RPE measures. Taking a single measure following a training session would appear to be much easier than using multiple measures of RPE throughout a resistance training workout. However, practitioners should also be aware that the RPE does not directly relate to the relative intensity used and appears to be dependent on the mode of resistance exercise that is used.

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AUTHORS BIOGRAPHY

Alison D. EGAN

Employment

Graduate assistant, Department of Health and Exercise Science, University of Oklahoma, USA

Degree

BS

E-mail: datsnail@yahoo.com

Jason B. WINCHESTER

Employment

Graduate assistant in the Exercise Biochemistry Lab in the department of Kinesiology at Louisiana State University, USA.

Degree

MS

Research interests

Strength, power, and speed production; resistance exercise; muscle physiology; methodology for testing power production; stretching and performance.

E-mail: jwinch2@lsu.edu

Carl FOSTER

Employment

Professor in the Department of Exercise and Sport Science, University of Wisconsin-La Crosse, USA.

Degree

PhD

Research interests

Clinical physiology, high performance physiology, exercise physiology

E-mail: foster.carl@uwlax.edu

Michael R. MCGUIGAN

Employment

Lecturer, School of Exercise, Biomedical and Health Sciences, Edith Cowan University, Australia

Degree

PhD

Research interests

Resistance training physiology, monitoring training

E-mail: m.mcguigan@ecu.edu.au

KEY POINTS

- The present study showed that session RPE values are not significantly different from the more traditional methods of measuring RPE during exercise bouts.
- Power training had significantly lower average and session RPE compared to both super slow training and traditional training
- It does appear that the resistance training mode that is used results in differences in perceived exertion that does not relate directly to the loading that is used.

Dr Mike McGuigan

School of Exercise, Biomedical and Health Sciences, Edith Cowan University, Australia