Monitoring Resistance Exercise Intensity Using Ratings of Perceived Exertion in Previously Untrained Patients With Prostate Cancer Undergoing Androgen Deprivation Therapy

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Abstract

Fairman, CM, LaFountain, RL, Lucas, AR, and Focht, BC. Monitoring resistance exercise intensity using ratings of perceived exertion (RPE) in previously untrained patients with prostate cancer undergoing androgen deprivation therapy. *J Strength Cond Res* 32(5): 1360–1365, 2018–Exercise has been shown to be safe and effective for patients with prostate cancer (PrCa). The monitoring of resistance exercise (RE) intensity is an emerging area of interest in RE prescription. Rating of perceived exertion (RPE) is one of the most commonly used methods but has not yet been validated in this population. Thus, the purpose of this study was to examine the relationship between RPE and RE intensity in PrCa. Data for this study were abstracted from baseline upper- and lower-body strength assessments from 2 previous trials (Individual Diet and Exercise Adherence Pilot Trial; Livestrong, Austin, TX, USA) in our laboratory investigating functional outcomes in patients with PrCa undergoing androgen deprivation therapy (ADT). A total of 75 participants from both trials were included in this study. Ratings of perceived exertion corresponding to 50, 70, and 90% 1 repetition maximum (1RM) were extracted from the results of participants' upper- and lower-body 1RM strength tests. The changes in RPE across increasing intensities were assessed using separate univariate analysis of variance (ANOVA). For each ANOVA, RPE was used as the dependent variable and intensity (50, 70, and 90%) used as the fixed factor. A univariate ANOVA revealed a significant difference ($p \leq 0.05$) among the RPE values for each intensity for both upper- and lower-body lifts. The results of our analyses suggest that RPE values rise linearly in response to increases in exercise intensity. Our study supports the concept that RPE may be a practical training tool to accurately estimate RE intensity in PrCa survivors undergoing ADT. Practitioners may consider using RPE to monitor and adjust RE intensity in this population.

Key Words weights, strength training, oncology, physical activity

Introduction

Androgen deprivation therapy (ADT) is the foundation of treatment for prostate cancer (PrCa) and is being implemented in the treatment of both locally advanced and biochemical PrCa recurrence. Although ADT is the standard systemic treatment for PrCa, the catabolic effects of ADT are associated with significant declines in muscle mass and physical function, putting patients with PrCa at greater risk of developing functional limitations as they age (5,12,14,15).

Resistance exercise (RE) has been recently proposed as an adjuvant supportive care intervention that can attenuate, or even reverse, some of the adverse physiologic, functional, and indeed psychological effects of prolonged ADT (4,11,20). Indeed, findings from several previous investigations demonstrate that resistance training consistently resulted in improvements in muscle mass, strength, body composition, and functional capacity in patients with PrCa undergoing active treatment (16,21).

Although the preliminary safety and efficacy of RE has been established in patients with PrCa undergoing ADT, there is a consensus among governing bodies that exercise prescription should be individually tailored with consideration to the participant's needs, preferences, physical function, and limitations (1,4). In this regard, personalization of the RE stimulus among patients with PrCa may lead to enhanced adherence and more favorable improvements in clinically relevant outcomes for these individuals. Nonetheless, it is critical to recognize that patients with cancer exhibit considerable heterogeneity with regard to their demographics, medical history, cancer type, treatment (type, dose, duration etc.), and training history. Thus, it is likely that the individual response, along with the physiological

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and psychosocial readiness to train, will vary substantially in this population. One important component of appropriate exercise prescription, modification, and progression is the concept of monitoring of training load (18,22).

Several methods have been proposed to monitor RE load or intensity, including force plates, accelerometers, and video analysis. However, the cost associated with laboratory equipment, coupled with the need for a trained technician, makes these methods impractical in a clinical setting. From a translational perspective, a more practical option may be the use of rating of perceived exertion (RPE) to monitor training intensity (24). Rating of perceived exertion has more traditionally been used to gauge exertion and intensity in an aerobic setting. However, recent investigations have emerged supporting its utility to measure both set and session intensity for resistance training in different populations (2,7,17). In addition to these studies, findings of previous research from our laboratory have demonstrated the utility of implementing RPE during acute RE in healthy untrained and trained adults (8–10). Nevertheless, knowledge of the accuracy of implementing RPE to measure RE intensity in patients with PrCa remains limited at the present time.

The use of RPE to accurately track RE intensity can be particularly useful to professionals working with cancer patients and survivors. The cancer population, particularly those undergoing active treatment, requires personalization and flexibility in their training to adjust for additional stress and fatigue that effects of the disease, and its treatments, may cause (13). Theoretically, using RPE to monitor training intensity can be used as a tool to monitor and adjust the training intensity in a way that can elicit an appropriate training stressor. Thus, the purpose of this study was to examine the RPE responses to varying RE intensities in patients with PrCa undergoing ADT and to determine whether RPE was able to differentiate between these different RE intensities.

Methods

Experimental Approach to the Problem

Data for this study were abstracted from 2 previous trials in The Ohio State University Exercise and Behavioral Medicine Laboratory investigating functional outcomes in patients with PrCa undergoing ADT. Briefly, all participants underwent a battery of physical function assessments, including upper- and lower-body strength. Demographic information along with data from the body composition and upper- and lower-body strength assessments were included in this study. For the primary outcomes of interest, we used participants' baseline 1 repetition maximum (1RM) tests for both upper- and lower-body strength. During 1RM testing, participants' perception of effort/intensity was recorded using the modified Borg Category Ratio (Borg CR-10) scale (3). Ratings of perceived exertion corresponding to 50, 70, and 90% 1RM were extracted from the results corresponding to each participant's 1RM strength tests.

Table 1. Participant characteristics.*

	Mean ± *SD*
Age (y)	68.8 ± 9.07
Height (cm)	174.3 ± 19.09
Ethnicity	
White	71
African American	5
Asian	2
Education	
High school or less	1
More than high school	75
Time on ADT (mo)	31 ± 29
Mass (kg)	93.63 ± 22.42
Body fat (%)	37.89 ± 7.48
Upper-body 1RM (kg)	76.10 ± 22.91
Lower-body 1RM (kg)	56.09 ± 17.39

*ADT = androgen deprivation therapy; 1RM = 1 repetition maximum.

Subjects

Selected descriptive characteristics of the participants are reported in Table 1. A total of 77 men (*M* age = 68.6 ± 9.1 years) who were on average 31 months on ADT treatment were recruited to participate in the study. Eligibility criteria for both trials were as follows: (a) histologically defined diagnosis of PrCa based on pathology reports and staging studies; (b) currently undergoing ADT with a planned course of at least 3 months of continuous therapy; (c) sedentary activity pattern with less than 60 minutes of structured exercise participation per week during the past 6 months; (d) free of any serious medical condition that precluded safe participation in an exercise program; (e) consent to participate from the treating oncologist and primary care physician;

Table 2. Borg scale of perceived exertion (CR10).

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

and (f) willingness to accept randomization and undergo the testing and intervention procedures. The trial was approved by the Ohio State University's Institutional Review Board, and all participants completed signed informed consent before beginning participation in either of the trials.

Procedures

Body Composition. Height was measured using a stadiometer. The BOD POD (BOD POD Body Composition System; Life Measurement Instruments, Concord, CA, USA) was used to determine body composition from air-displacement plethysmography. Before each test, the BOD POD was calibrated according to the manufacturer's instructions with the chamber empty using a cylinder of known volume (49.558 L). Participants, wearing tight-fitting compression shorts and a swimming cap, were asked to enter and sit in the fiberglass chamber. The BP was sealed, and participants were instructed to breathe normally for approximately 20–30 seconds while body volume (BV) is estimated. Thoracic gas volume was estimated using BOD POD software. This value was used to correct BV for thoracic gas volume. Body volume, percent body fat, fat mass, and fat-free mass (FFM) were estimated using the system's software. Body mass index was calculated using height and weight from the stadiometer and BOD POD, respectively.

One Repetition Maximum Procedure. Muscular strength was assessed using standardized 1RM testing protocols for the chest press and leg extension exercise. One repetition maximum tests are the standard by which muscular strength is evaluated and have been established to be safe for older adults (19). Participants were familiarized with the chest press and leg extension machines and received instruction on proper form. Participants began 1RM testing for each exercise by completing a warm-up set of 10–12 repetitions with roughly 10–20% of body weight, depending on patient characteristics and previous experience. Participants then performed multiple sets of each exercise with stepwise increases in weight until they performed the lift with the maximal amount of weight for 1 repetition, with a goal of reaching the 1RM by the fifth or sixth set. Participants rated the difficulty of the set using modified Borg Category Ratio (Borg CR-10) scale ranging from 1 (not at all difficult) to 10 (extremely difficult). The participants' perceived rating of difficulty was used to choose the first weight at which a 1RM test was attempted. Participants were subsequently asked to lift the weight once and to continue to perform single repetition lifts with increasing weight, separated by a 3–5-minute rest interval, until a maximum weight was reached and recorded as the 1RM.

Rating of Perceived Exertion. Participants were asked to rate their level of perceived exertion using a modified Borg Category Ratio (Borg CR-10) scale (21) with standardized instructions and anchoring procedures, immediately after each set. Participants were given a visual of the chart to examine (Table 2) and asked to use any number on the scale to rate the effort for each set. A rating of 0 was to be associated with no effort (rest), whereas a rating of 10 was considered to be maximal effort. Rating of perceived exertion values were extracted for loads corresponding to 50, 70, and 90% 1RM of each lift for each participant. Because of the fluid nature of 1RM testing, not all participants reached a weight and RPE to meet/achieve each respective intensity. Consequently, only data from those who lifted weights corresponding to 50% ($n = 29$ Upper; $n = 41$ Lower), 70% ($n = 27$ Upper; $n = 36$ Lower), and 90% ($n = 40$ Upper; $n = 43$ Lower) were included.

Statistical Analyses

The changes in RPE across increasing intensities were assessed using separate univariate analysis of variance (ANOVA). For each ANOVA, RPE was used as the dependent variable and intensity (50, 70, and 90%) used as the fixed factor. The significance level set a priori for analysis was $p \leq 0.05$. All analyses were conducted using SPSS 22.0.

Results

Demographic criteria are reported in Table 1. Men were on average, 68.8 years, 71% white, class I obese, and 2.6 (±2.4) years from diagnosis. The mean RPE for each intensity for both upper-body and lower-body 1RM is shown in Table 3. A univariate ANOVA revealed a significant

Table 3. Individual exercise RPE for low, moderate, and high intensities.*†

Exercise	50% 1RM RPE, mean ± *SD*	70% 1RM RPE, mean ± *SD*	90% 1RM RPE, mean ± *SD*
Upper-body 1RM	5.31 ± 1.98	6.55 ± 1.74	8.24 ± 1.47
Lower-body 1RM	5.83 ± 1.67	7.33 ± 1.39	8.50 ± 1.22

*RPE = rating of perceived exertion; 1RM = 1 repetition maximum.
†1RM exercise test for the upper body and lower body was assessed using Cybex Rotary Chest and Leg Press Machines, respectively.

Table 4. Multiple comparisons for varying resistance exercise intensities.*

Intensity	Intensity	Mean difference	Std. Error	Sig.
Upper-body 1RM				
50%	70%	−1.24†	0.46	0.023
	90%	−2.93†	0.41	0.000
70%	50%	1.24†	0.46	0.023
	90%	−1.68†	0.43	0.000
90%	50%	2.93†	0.41	0.000
	70%	1.68†	0.43	0.000
Lower-body 1RM				
50%	70%	−1.50†	0.33	0.000
	90%	−2.67†	0.31	0.000
70%	50%	1.50†	0.33	0.000
	90%	−1.17†	0.33	0.001
90%	50%	2.67†	0.31	0.000
	70%	1.17†	0.33	0.001

*1RM = 1 repetition maximum.
†Mean difference is significant at the $\alpha = 0.05$ level.

difference ($p \leq 0.05$) among the RPE values for each intensity for both lifts (Table 4). For upper-body 1RM, 70% was significantly greater than 50% ($p = 0.023$), and 90% was significantly greater than 50% ($p = 0.001$) and 70% (0.001). For lower-body 1RM, 70% was significantly greater than 50% ($p = 0.001$), and 90% was significantly greater than 70% ($p = 0.001$) and 50% ($p = 0.001$). Rating of perceived exertion for lower-body 1RM was not statistically different than that for the upper body at any intensity. Ancillary analyses were run to examine if any of the results of the primary analysis were influenced by baseline 1RM, baseline RPE, FFM ($p = 0.665$), or training status. Three separate analyses of covariance were run with (a) baseline 1RM and RPE and (b) FFM as covariates. Results of each analyses controlling for the effects of baseline 1RM (Upper 1RM $p = 0.863$; Lower 1RM = 0.207), baseline RPE (Upper RPE $p = 0.911$; Lower RPE $p = 0.685$), FFM ($p = 0.665$), or training status ($p = 0.797$) not significant and therefore did not change the interpretation of the primary analysis that there was a significant difference among the RPE values for each intensity on both lifts (Figure 1).

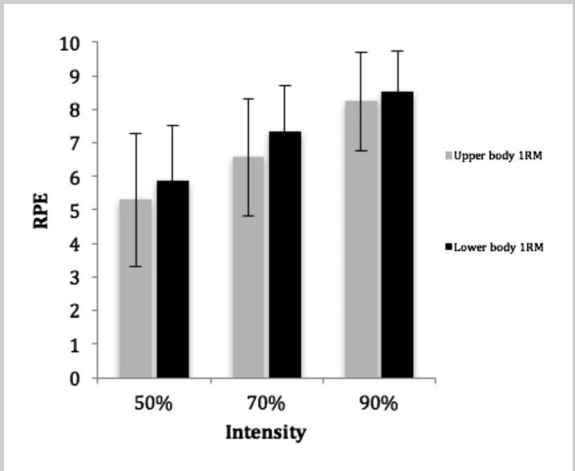

Figure 1. Individual rating of perceived exertion (RPE) for low, moderate, and high intensities for each lift. 1RM = 1 repetition maximum.

Discussion

This study examined the RPE responses to increasing RE intensity in patients with PrCa undergoing ADT. The results suggest that RPE has a positive linear relationship to increases in exercise intensity. Performance of a greater amount of repetitions at 50% 1RM was perceived as being less difficult than performing fewer repetitions at higher intensities. The results of this analysis further support the data provided in previous trials examining ratings of perceived exertion in response to RE intensity in different, noncancer populations (7,17).

The *SD* for RPE was approximately 1.5 for any given intensity. This is similar to what has been observed in other untrained/older adult populations (6,7). Nevertheless, in a study examining the perceived exertion to various resistance training loads in participants of different training age, Testa et al. (2012) found that the relationship between RPE and training load was influenced by training state (23). Moreover, Zourdos et al. (2016) recently found considerably less variation in the RPE response to any given RE intensity in experienced lifters than novice lifters (24). These studies suggest that training age and RE training experience may very well have an influence on the accuracy of RPE to gauge RE intensity. Furthermore, it is plausible to propose that this

difference may potentially be due, in part, to trained individuals having a greater integration of the sensory signals of muscle activity (23). Consequently, it should be noted that time should be spent familiarizing participants with the scale and anchoring techniques over the course of a training program in an attempt to improve the precision of RPE as a training tool.

The acute nature of resistance training sets often poses questions regarding the efficacy of a traditional 1–10 RPE scale to measure intensity. In an attempt to address this, a Repetition in Reserve (RIR) Scale has recently emerged as a surrogate to the traditional RPE scale as a measure of RE intensity. The RIR measures "repetitions in reserve" after each set, referring to the amount of repetitions that theoretically could still be completed after the completion of each set (i.e., an RIR of 9 would indicate one could do one more repetition, an RIR of 8 would indicate 2 more repetitions, etc.). Indeed, Zourdos et al. found RIR to be a valid measure of RE intensity in both experienced and novice lifters (24). Thus, it is possible that using the RIR in tandem with the RPE scale or using the RIR alone may represent a viable alternative to the RPE scale used in this study for potentially enhancing the accuracy of perceptual feedback of intensity among patients with PrCa. However, the RIR scale is still relatively new and has not yet been examined in a cancer population. Consequently, future investigations incorporating both the RPE and RIR measures are warranted to examine the validity of RIR as a measure of RE intensity among patients with PrCa.

As a result of varying demographics, medical history, cancer type, and treatment (type, dose, duration, during vs. post, etc.), the need for personalized and appropriate exercise prescription, modification, and progression is critical. An important concept of appropriate prescription and progression in the cancer population is the monitoring and adjusting of training load. Our study supports the concept that RPE may be a practical training tool to estimate RE intensity among PrCa survivors. This may very well allow for adjustments in exercise intensity and provide an appropriate training stimulus in accordance with fluctuations in readiness to train in PrCa survivors undergoing ADT. Perhaps also adjustments based on levels of fatigue experienced as a result of treatment or previous RE sessions?

Although the present findings contribute to knowledge on influence of RE intensity on RPE, selected limitations of the study must also be acknowledged. For example, studies evaluating RPE as a tool to monitor training load or intensity often perform a 1RM baseline assessment for each lift, followed by exercise sessions at set intensities under investigation, separated by a "wash-out" period. We extracted RPE values corresponding to 50, 70, and 90% 1RM from the baseline assessments, which could be seen as a limitation. Thus, although RPE changes with increasing RE intensity, it is unclear how full RE sessions with multiple sets and exercises at varying intensities would influence RPE. Consequently, more research investigating the relationship between training variables (volume, load, time, etc.) on both set and session RPE is warranted.

The present sample comprises untrained, older patients with PrCa undergoing ADT. Thus, it should not be assumed that the RPE response to varying RE intensities would be representative of survivors with more RE training experience, or indeed other cancer survivors (i.e., breast or lung). Accordingly, future investigations involving more diverse samples are necessary to extend these findings to other population subgroups, such as different cancer survivors, survivors with differing training backgrounds, or those undergoing active treatment vs. those who have completed therapy. In particular, the use of RPE to appropriately prescribe a training load during a resistance training program among PrCa should be investigated.

Finally, it is important to acknowledge that findings from ancillary analyses controlling for important variables including baseline 1RM and RPE, lean body mass and RE experiences suggest that these did not systematically influence the observed association between RE intensity and RPE. It is possible that the present sample size does not provide adequate statistical power to detect the associations among these variables. Accordingly, additional research incorporating a larger sample of patients with PrCa is necessary to adequately delineate the nature of these relationships.

In summary, the present findings revealed that RPE increases in a positive linear fashion in response to increasing RE intensity. These findings provide theoretical basis for future studies to build on and attempt to establish more clearly defined relationships with RPE and RE intensity in the cancer population.

Practical Applications

Given the paucity of literature examining RPE in a cancer population, recommendations for RPE-based training in this population are precluded. Nevertheless, RPE may be a viable and noninvasive tool for monitoring RE intensity in a cancer population that practitioners and professionals may use to adjust the load, intensity, or indeed exercise prescription. We suggest that future research be conducted investigating the utility of an RPE scale as a method of RE load prescription and progression.

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