Monitoring Plyometric Exercise Intensity Using Rating of Perceived Exertion Scale

Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Manuscript Preparation
E – Funds Collection

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Abstracts. *The aim of this investigation was to determine the effectiveness of rating of perceived exertion (RPE) scale to measure plyometric exercise intensity during low (L), moderate (M) and high (H) intensity. Fourteen physically active students (age; 21±1.1 y, height; 178.7±8.2 cm and body mass; 74.6±9.1 kg) volunteered to participate in this study and performed each intensity once separated with 24 h recovery. The H consisted of 1 set of 5 repetitions at 90% of the subject's vertical jump height (VJH). The M consisted of 10 repetitions at 70% VJT, and the L consisted of 1 set of 15 repetitions at 50% VJH. RPE was measured following the completion each intensity using 0-10 Borg RPE scale. Data was analyzed using repeated measures ANOVA and the level of significant was set at $p < 0.05$. The results indicated increases in RPE following enhancing exercise intensity ($p < 0.05$). Performing fewer repetitions at a higher intensity was perceived to be more difficult than performing more repetitions at a lower intensity. The results of the current investigation revealed that the RPE method is effective in monitoring different plyometric exercise and training intensities and it can be recommend that strength and conditioning professionals and athletes use the RPE method based on the effectiveness tool for monitoring their plyometric exercise and training sessions at different intensities.*

Keywords: perceived exertion, maximal effort, stretch-shortening cycle.

INTRODUCTION

It has been well documented that rating of perceived exertion (RPE) scale is a well-established method for screening intensity of resistance and endurance exercises in adults and children [1,2,3,4,5]. This scale has been widely researched for its use in both clinical and exercise setting [6]. For strength and conditioning professionals and researchers designing exercise intensity is one of the important problems and the RPE scale is valid and became a standard method of measuring the level of intensity experienced during physical activity [6].

It appears that with increasing the resistance exercise intensity, the RPE is higher [1,2,3,7]. Moreover, subjects tend to perform more repetitions with low RPE compared with low repetitions with high RPE [3,8]. Although, resistance training is a well training mode for many different populations wishing to increase physical fitness, strength and power [9,10], newly a large number of conditioning professionals and athletes used plyometric training for the promotion of muscular performance and power in their training schedule [11,12]. Therefore, monitoring plyometric exercise (PE) intensity using RPE scale is vital for a successful periodized exercise plan.

Since, designing exercise training can affect a myriad of variables such as number of sets, number of repetitions, intensity, exercise type and etc, thus performing PE is affected by these variables [13]. Different intensities of PE may induce different responses from the muscle and neurological system. Therefore, monitoring PE intensity with valid tool is necessary.

This study was designed to examine the use of RPE after different intensities of PE such as low, moderate and high. This would benefit coaches, strength and power athletes by providing a reliable method of assessing and monitoring different intensities of PE in their periodized plan. Therefore, the purpose of this study was to evaluate the effectiveness of using RPE (Borg 10-category) scale to monitor of PE intensity at different intensities.

METHODS

Participants and experimental design

The participants were fourteen physically active students at the university and were familiar with plyometric and resistance training (Table 1). The participants were healthy, free from any lower body injuries and had not problems for their exclusion of this study. Participants were carefully informed about the design of the study and signed an informed consent document prior to the start of the study. All subjects were physically active men and performed resistance or sport training 3 times a week for 90-min. The study was approved by the institutional review boards of the University and the declaration of Helsinki. Three days before starting treatments, the participants were recruited to the laboratory and informed about the experimental design of the study and then were tested for height using a wall-mounted stadiometer (Seca 222, Terre Haute, IN) recorded to the nearest cm and body mass using a medical scale (Tanita, BC-418MA, Tokyo, Japan) with the nearest 0.1 kg. During this session maximum vertical jump was determined according to the best value of 5 vertical jumps. After assessing maximum vertical jump height, for assessing RPE during the exercise, standard instructions and anchoring procedures were explained. At testing days, each participant performed 1 set of PE with maximal effort and after completing exercise the rate of perceived exertion was determined.

Table 1. Participants characteristics (mean ± SD)

Subjects (*N*=14)	Age [y]	Height [cm]	Body mass [kg]	VJH [cm]
University students	21±1.1	178.7±8.2	74.6±9.1	38.8±6.3

Plyometric exercise

A randomized, crossover experimental design was used, with each subject performing 3 intensities. Prior to starting the exercise, participants performed 10-min warm up including 5-min jogging and 5-min stretching and ballistic movements. Participants performed 1 set of 15 repetitions of 50% VJH based on Low intensity. The Moderate intensity consisted of 1 set of 10 repetitions with 70% VJH and High intensity consisted of 1 set of 5 repetitions with 90% VJH. The participant was asked to maintain the jump height for each subsequent jump that marked in the Vertec (Power System, Knoxville, Tennessee). The investigator carefully supervised the exercise to eliminate the risks of unexpected injury. The cool-down period consisted of approximately 5-min of walking and jogging followed by static stretching of the major muscle

groups of the legs.

RPE measures

During the familiarization session, each subject was given instructions on the use of the Borg 10-category scale for RPE (Table 2). For assessing RPE during the exercise session, standard instructions and anchoring procedures were explained during the familiarization session [6]. Participants were asked to use any number on the scale to rate their overall effort. A rating of 0 was to be associated with no exertion (rest) at all and a rating of 10 was considered to be maximal exertion and associated with the most stressful exercise ever performed. Following the PE at different intensities the subject was asked "How would you rate your effort?" The participants would verbally indicate a number to rate their overall effort. This use of RPE method has been used successfully to determine exercise intensity in previous study [3,7].

Table 2. The Borg 10-category scale for rating of perceived exertion. After each intensity, the subject was shown the scale and asked "How would you rate your effort ?"

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

Statistical analysis

Data are presented as mean ± SD. Data normality was checked with the Kalmogorov-Smirnoff test. A repeated- measures analysis of variance (ANOVA) and Fisher pairwise least significant difference (LSD) post hoc test was used to analyze the RPE responses after different intensities (L, M and H) of PE. Significance level was set at $p < 0.05$.

RESULTS

Within-subject repeated measures ANOVA showed a significant difference among the mean RPE values of each intensity ($p < 0.05$). The 70% intensity RPE values were significantly higher than the 50% intensity RPE values, and the 90% intensity RPE values were significantly higher than the 50% and 70% intensity. RPE values as displayed in Figure 1.

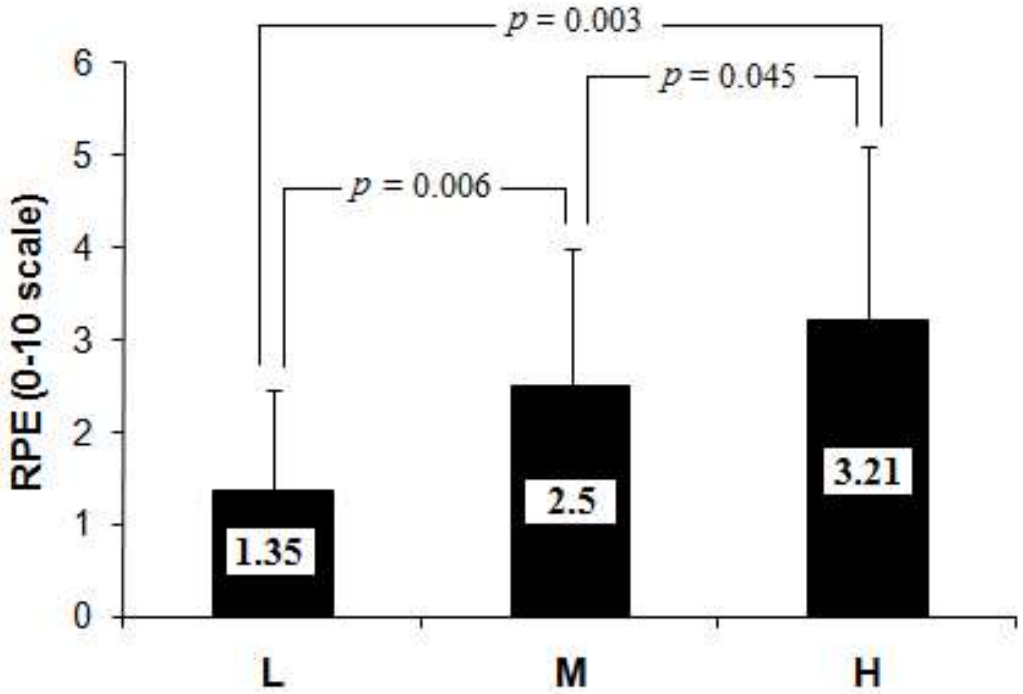

Figure 1. Ratings of perceived exertion (RPE) for the different intensities of plyometric exercise.

DISCUSSION

Previous researches has demonstrated the effectiveness of the RPE method for monitoring resistance and endurance exercise training intensity in adults and children [1-5]. There is no previous research investigating the efficacy of RPE method for monitoring PE intensity. The purpose of the present investigation was to compare three different intensities of PE (L, M and H) on RPE during vertical jump exercise. We found greater increases in RPE for H when compared with L and M, also greater RPE for M in comparison to L.

Resistance exercise has strong eccentric component and it seems that this phase of resistance exercise has relationship with the nature of PE. Because of plyometric exercise and training consisted of rapid eccentric to concentric action and induce improvement in performance, so it can be common point between resistance and plyometric exercise and training. There is a strong linear relationship between RPE and exercise intensity. This means that during exercise movement, corollary discharges from the motor cortex are concurrently sent to both the recipient muscle and the somatosensory cortex. The higher load during PE results in greater tension development and increased motor unit recruitment and firing frequency [8]. A positive slope in RPE, indicating an increase in the intensity of the perceptual signal originating in the active skeletal muscle throughout each set of exercises, may be related to metabolic and/or neurological factors associated with fatigue. Fatigue during plyometric exercises could be due to the depletion of plasma creatinine, decreasing the pH with increasing muscle lactate accumulation, or carbohydrate depletion [6,14] and resulting increases in perception of exertion during PE.

As previously demonstrated, muscles forced to overcome a heavy load require greater tension development, which requires an increase in motor unit recruitment and firing frequency

[6,8]. For greater motor unit recruitment to be accomplished the motor cortex may send stronger signals to the sensory cortex; this gives rise to increased perception of effort. It has been theorized that these stronger corollary signals may be the primary cause of the differences in RPE of varying intensities as shown by previous studies and the present study [6,15,16,17]. The difference in RPE has also been observed in increasing intensities of aerobic cycling [8], suggesting that the increase in RPE demonstrated by this and several previous studies pertains not only to the anaerobic energy system but to the aerobic energy system as well.

Overall, when the PE intensity increases, muscles must overcome to this increases load resulting greater tension development in active muscle fiber requires an increase in motor unit recruitment and firing frequency [3]. To produce this greater force, additional skeletal muscle fibers must be recruited. As such, a greater number of motor units must be stimulated. This is accomplished by sending a stronger efferent signal from the motor cortex. Smaller, more excitable motor units are recruited first, followed by larger, less excitable motor units. A stronger stimulus may be necessary to cause these larger, less excitable motor units to contract. It is unclear whether the stronger signal is due to an increased efferent firing rate, a stronger efferent signal required for depolarization, or a combination of both [7]. These neuromotor variables were not measured in the current study. Regardless, it is believed that more intense corollary signals sent to the sensory cortex from the motor cortex as a result of the above process during PE may be the primary cause of the differences observed in RPE among intensities [1].

CONCLUSION

Data from this study provide further confirmatory evidence that the RPE method is a reliable and useful tool for researchers, strength coaching and athletes and is reliable method of quantifying exercise-training intensities. To summarise, the present study demonstrated that RPE increases when vertical jump intensities increased. The rate of perceived exertion was higher for H as compared to L and M, also the perceived exertion was higher for M when compared with L. These findings can be key note for strength and conditioning professionals and athletes to monitor their plyometric exercise and training intensities when performed at different intensities.

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Recevied: 30.10.2013; Accepted: 20.12.2013; Published online: 10 .01.2014