Effects of High Volume Weight Training on Lactate, Heart Rate, and Perceived Exertion

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Reference Data

ABSTRACT

This study investigated the response of lactate [La], heart rate (HR), and rating of perceived exertion (RPE) to acute resistance exercise following a high volume weight training program. Twenty-three untrained male subjects were divided into experimental (GE, n = 15) and control groups (C, n = 8). A pretest (Pre) was performed consisting of full squats for 1 set of 10 repetitions (reps) at 45% of a 1-rep maximum (1-RM), 1 set of 10 reps at 55% 1-RM, and 5 sets of 10 reps at 62.5% 1-RM. Following 8 weeks of training by GE, all subjects were retested (Post) using the original Pre testing protocol. Results showed that peak [La] decreased from 11.9 ± 4.2 mmol · L⁻¹ to 3.1 ± 2.6 mmol · L⁻¹ (p < 0.05) as a result of training. GE displayed a significant (p < 0.05) reduction in heart rate at the end of each set. Significant decreases in RPE during exercise were also observed. These findings suggest that an 8-week high volume weight training program emphasizing large muscle groups can reduce the physiological and perceived stress associated with resistance exercise. The reductions in [La], HR, and RPE following training may enhance an individual’s ability to continue work during bouts of acute resistance exercise.

Key Words: weight lifting, exercise, stress

Introduction

Several parameters have been used to estimate the degree of physiological stress imposed by physical exercise; among them are heart rate (HR) and blood lactate [La] responses. It is well established that aerobic training can improve the HR and [La] responses to a given endurance exercise bout (12, 22). However, there is much less information on the effects of chronic weight training on the HR and [La] response to a single weight training session.

Blood lactate concentrations have been observed to increase during bouts of acute resistance exercise (4, 14, 29). Some information suggests that [La] will be lower as a result of weight training exercise at both absolute values (27) and at relative (% 1-RM) intensities (18) in trained weight lifters compared to untrained subjects. Marcinik et al. (16) have observed higher lactate thresholds and improved endurance performance as a result of a 12-week weight training program. Additionally, a decreased postweight training exercise (% 1-RM) lactate concentration as a result of short-term (1 month) training has also been observed (5). Other cross-sectional (6, 15) and short-term longitudinal studies (1, 11), using a variety of test protocols, have not found indications of improvement in cardiovascular or metabolic parameters that would be associated with reduced physiological stress as a result of weight training.

Few longitudinal studies have examined the effect of weight training on exercise HR. Petersen et al. (21) found lower exercise HR during submaximal cycling following a 6-week high velocity circuit training program. By contrast, Hurley and co-workers (11) found no significant differences in exercise HR when subjects performed treadmill exercise requiring 50% VO₂max following a 16-week high intensity Nautilus strength training program. In a cross-sectional study, Stone et al. (27) found that experienced weight lifters had significantly lower exercise HR than nonlifters when HR was measured during progressive resistance exercise. Based on the results of these studies, it is not clear what effects chronic weight training would have on subsequent responses to resistance exercise.

Differences in training volume (total work), intensity (average mass lifted), relative intensity (% 1-RM), repetitions per set, rest periods between sets, or training state of the subjects may influence the outcome of a weight training program on various physical and physiological parameters including HR and [La] adaptations (8, 25). It has been suggested (8, 25) that weight training programs emphasizing large muscle mass exercises and that are of sufficient training volume and intensity are more likely to reduce physiological stress.
analyzed using the appropriate contrasts. Statistical significance was set at $p < 0.05$.

**Results**

The 8-week weight training program produced a significant increase in 1-RM squat strength in the experimental group. Pre 1-RM squat values were $99 \pm 16$ kg (mean $\pm$ SD) with an increase to $122 \pm 18$ kg Post. No significant change was noted in the control group ($89 \pm 15$ kg Pre vs. $94 \pm 22$ kg Post).

Significant ($p < 0.05$) main effects for test and trial were observed for [La]. Acute resistance exercise resulted in significant increases in [La] at Pre and Post for both GE and C (Figure 1). A significant ($p < 0.05$) Group $\times$ Test interaction was also observed. Peak [La] at T3 dropped significantly from $11.9 \pm 4.2$ mmol $\cdot$ L$^{-1}$ to $5.1 \pm 2.6$ mmol $\cdot$ L$^{-1}$ from Pre to Post in GE. No significant difference was found for peak [La] in C following training. Lactate concentrations decreased significantly from immediately after T3 to T4 in both groups. Pre vs. Post training [La] at T4 was significantly different for GE but not for C. Plasma [La] was still significantly elevated above T1 values at T4 for C but not for GE.

Significant ($p < 0.05$) Group $\times$ Test interactions were observed for HR and RPE. No significant differences were observed in resting heart rate between GE and C before or after training. However, heart rate response to acute resistance exercise was significantly lower following training in the experimental group (Figure 2). The difference in heart rate response was evident following S1 and lasted throughout the remaining sets. Peak HRS were $185 \pm 10$ beats $\cdot$ min$^{-1}$ during Pre and $161 \pm 11$ beats $\cdot$ min$^{-1}$ during Post.

![Figure 1. Plasma lactate response (mmol $\cdot$ L$^{-1}$) to resistance exercise in experimental (GE) and control (C) groups following Pre and Post testing sessions. Asterisk (*) indicates significant ($p < 0.05$) differences from Pre to Post in GE. Values are expressed as the mean $\pm$ SD.](image1)

![Figure 2. Heart rate response (beats $\cdot$ min$^{-1}$) to resistance exercise in experimental (GE) and control (C) groups following Pre and Post testing sessions. Asterisk (*) indicates significant ($p < 0.05$) differences from Pre to Post in GE. Values are expressed as the mean $\pm$ SD.](image2)

![Figure 3. The response of rating of perceived exertion (RPE) to resistance exercise in experimental (GE) and control (C) groups following Pre and Post testing sessions. Asterisk (*) indicates significant ($p < 0.05$) differences from Pre to Post in GE. Values are expressed as the mean $\pm$ SD.](image3)

Ratings of perceived exertion were significantly lower at each set (S1–S7) from Pre to Post in the experimental group (Figure 3). Neither HR or RPE showed any significant changes in the C group.

**Discussion**

Results of the present study demonstrate that an 8-week, high volume weight training program results in beneficial effects on [La], HR, and RPE responses to weight training exercise at an absolute load (Repetitions $\times$ Weight). These posttraining responses suggest