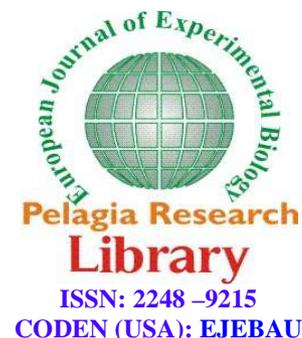




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### The comparison of three type of exercise sequence on hormonal response after resistance exercise

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#### ABSTRACT

Exercise order is a critical factor in design of resistance training. The purpose of this study is comparison of three type of exercise order on hormonal responses following a bout of resistance exercise. Twelve subjects completed three sessions (3 sets; 70% 1-RM) separated by a week and exercise order was so that participants either lifted with a upper to lower body (Order A), lower to upper body (order B) or one exercise in upper body and one exercise in lower body order (Order C). Total testosterone (TT), growth hormone (GH), insulin like growth factor-1 (IGF-1) and cortisol (C) concentrations were measured before and immediately after each sequence. The results indicate that the GH concentration increased after all sessions, but the increase was not significantly difference between groups ( $p < 0.05$ ). No differences were observed between sessions for TT, C, or IGF-1 at baseline or immediately after resistance exercise. These results indicate that performing exercises first in upper-body/lower-body or alternate in a bout of resistance exercise was not to leads difference in hormonal response.

**Keywords:** Exercise Sequence Cortisol, Insulin, Growth Hormone, Total Testosterone

#### INTRODUCTION

Resistance exercise stimulates acute changes in the rate of muscle protein turnover, resulting in an increase in both protein synthesis and protein degradation [1]. Different protocol of resistance exercise provide different hormonal milieu in human body. Factors that influence hormonal responses after a bout of resistance exercise known as acute program variables [2]. Acute program variables for resistance training include exercise choice, number of sets, resistance used, rest-period length, and the order of exercises [2]. Although most of these variables have been extensively studied over the past 2 decades [3], few scientific data exist regarding the effect of the exercise order on exercise performance [4,5]. Exercise order refers to a sequence of resistance exercises performed during one training session. Traditional exercise order dictates large muscle group or multijoint exercises should be performed before small muscle group or single joint exercises, because this exercise sequence may result in the greatest long-term strength gains [4, 6, 7, 8]. Furthermore, exercising larger muscle groups first has been theorized provide a greater training stimulus to all the muscles involved in an exercise, which may offer greater potential for tissue remodeling [9]. Recently Simão et al. [5, 10] observed that performing either large or small muscle group exercises at the end

of a resistance training sequence resulted in significantly fewer repetitions compared to when the same exercises were performed early in the training session.

Exercise order may influence metabolic and hormonal response to a bout of resistance exercise. It appears that the acute GH response to resistance exercise is highly influenced by the metabolic properties of the protocol such as lactate [2, 11]. Additionally, Bellezza et al [12] shown that during exercise blood lactate was lower in the small to large exercise order. On the other hand, initiate of exercises with lower body may stimulate greater anabolic hormone, because large muscles located in lower body [9]. Therefore this study was to investigate the influence of exercise order and its influence on hormonal responses to acute bouts of resistance exercise.

## MATERIALS AND METHODS

*Subject.* The subjects of this study were 12 young volunteered men with no regular exercise or resistance training prior to the start of the study. The subjects, physical characteristics are listed in table 1. Subjects completed a health history questionnaire and par-Q before the start of the study and gave written consent after being informed of the risk associated with the study. Subject with contraindications to exercise as outlined by the American college of sport medicine and/ or who had consumed any nutritional supplements anabolic steroids 6 months prior to the study were excluded from participation.

*Experimental procedure.* In order to investigate the influence of exercise order on hormonal responses the subjects visit weigh room four sessions that separated by 1 week of rest to ensure proper muscle recovery from the previous session. During the first session, the 8-10RM was determined for all eight exercises being used in the study. Participants were asked to return two more times with 48–72 hours of rest between visits to ensure proper muscle recovery from the previous session. For sessions 2, 3 and, 4 exercise order was randomly determined so that participants either lifted with a upper to lower body (Order A), lower to upper body (order B) or one exercise in upper body and one exercise in lower body order (Order C). Order A consisted of the 1) bench press, 2) barbell bicep curl, 3) supine triceps extension, 4) lat pull down, 5) leg press, 6) seated machine leg extension, 7) seated machine leg curl, 8) calve raises. Order B consisted of the 1) leg press, 2) seated machine leg extension, 3) seated machine leg curl, 4) calve raises, 5) bench press, 6) barbell bicep curl, 7) supine triceps extension, 8) lat pull down. Order C consisted of the 1) bench press, 2) leg press, 3) barbell bicep curl, 4) seated machine leg extension, 5) supine triceps extension, 6) seated machine leg curl, 7) lat pull down, 8) calve raises.

*Blood sampling:* Blood sampling were obtained prior to exercise and immediately post-exercise period for analysis of cortisol (CORT), Growth Hormone (GH), total testosterone (TT) and INS like Growth Factor-I (IGF-I). After a 4-h fast, subjects sat quietly for a further 15-min period prior to blood collection to minimize hormonal fluctuations related to anticipatory responses. Venous blood samples were obtained from the antecubital vein into 10 ml collection tubes. Blood samples were allowed to stand at room temperature for 20 min and then centrifuged for 10 min at 3000 rpm. The serum was then removed and frozen at  $-20\text{ }^{\circ}\text{C}$  for later analysis. Glucose was determined by an enzymatic spectrophotometric method (Dimension Xpand, Biomer Inc., Germany). INS, CORT, GH, total testosterone and IGF-1 concentrations were determined in duplicate and the average concentrations reported using commercially available ELISA kits (Diagnostics Systems Laboratories, Biomer Inc., Germany).

*Statistical analysis:* Data was analyzed utilizing standard descriptive statistics, paired *t* tests to compare within group differences between pre- and post exercise, and one-way ANOVA with repeated measures to compare differences between the groups in hormonal responses. Analysis was performed using the Statistical Package for Social Sciences (SPSS v11.5). Significance was accepted when  $P < 0.05$ . Values are expressed as mean ( $\pm$ SD).

## RESULTS

Result from one-way ANOVA with repeated measures indicate there were no significant difference ( $p > 0.05$ ) between responses of cortisol, GH, testosterone and IGF-1 concentrations after three sessions of resistance exercises. The result, also, indicate significant increases ( $p < 0.05$ ) in GH concentrations after resistance exercises with any exercise order (figure 1).

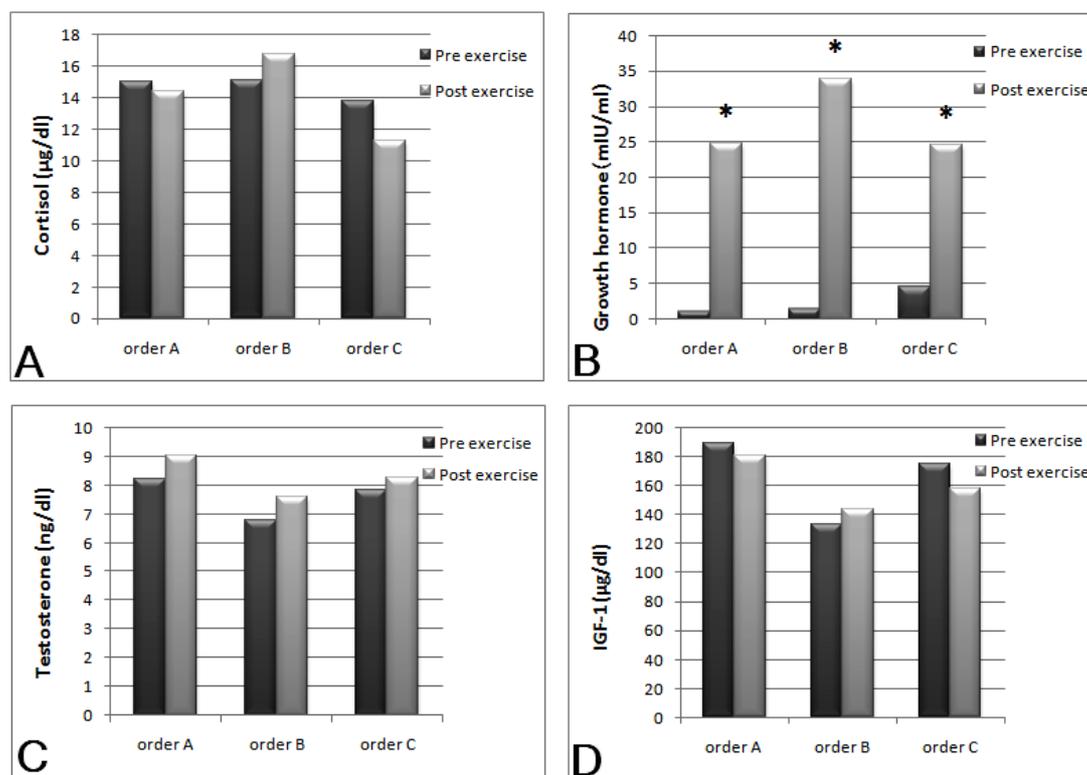


Figure 1. A representation of the means ( $\pm$ SD) for A. Cortisol responses before and after exercise B. GH responses before and after exercise C. TT responses before and after exercise D. IGF-1 responses before and after exercise

\* significantly different ( $P < 0.05$ ) from pre exercise

## DISCUSSION

The purpose of this study was to investigate the effects of exercise order on hormonal responses. The key finding of the present study is that the onset of exercises with upper or lower body limbs did not present significant differences hormonal responses after a bout of resistance exercise. In this study there were no significant changes in CORT, TT, and IGF-1 plasma concentrations after exercise. This indicates that the physical stress of resistance exercise was not enough for stimulate of hormonal changes such as CORT, TT, and IGF-1. Most of study suggested that Resistance exercise can acutely increase serum concentrations of hormones such as testosterone, cortisol and IGF-1 [2, 13, 14, 15, 16]. The magnitude of this elevation is dependent on the intensity [17,22], volume [18], rest interval [9, 19] and exercising muscle mass [18,23] of the resistance exercise bout. Simply, exercising a large muscle mass at a moderate–high intensity and with high volume and short rest intervals leads to greater rises in GH, IGF-1 and testosterone [2]. In current study performed eight exercises with upper and lower body by three sets at moderate intensity (70-75% 1RM) and with 90 second rest between sets that may not stimulate CORT, TT and IGF-1 responses.

Other finding of current study is increase GH plasma concentration after three sessions of resistance exercise. Increase in third session (order C) is greater than other session (order A and B). Although the higher GH response in order C were not significant, but indicates that resistance exercise with these order maybe increases physical stress and stimulates GH secretion. Well stabilized that GH secretions during and following resistance exercise are related with volume of muscles involved in exercise and total work performed in a bout of exercise [2]. However research suggests that the metabolic properties of the muscles affect the GH response. That is protocols that cause high lactate levels such as programs that stress large muscle mass and that use relatively short rest intervals and thus stressing the fast glycolytic fibers, produce the most substantial increases in GH [18]. Unlike order A and B, in order C, upper and lower body exercises performed in alternate orders, thus muscles in upper and lower could rest longer time and contract with more force. This is probably that performing exercises in alternate order induce higher GH response.

In summary, the major findings of the present study indicate that the onset of exercises with upper / lower body or alternate order did not present significant differences in hormonal responses after a bout of resistance exercise, but more information about effect of exercise order on hormonal responses need future investigations.

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