HORMONAL RESPONSE TO DIFFERENT REST INTERVALS DURING RESISTANCE TRAINING WITH LIGHT LOADS

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Annotation. *Purpose:* The purpose of the present study was to determine the appropriate rest time between sets during weight training with light load. *Material:* Seventeen cadet wrestlers (age =16.7±0.6 yrs.; height =169.2±8.2 cm; and weight =51.4±7.9 kg) were recruited from wrestling clubs in the Iranian province of Kurdistan and served as subjects in this study. This study was conducted over seven sessions with 48 hours recovery between sessions. In the first session, the characteristic features of subjects were recorded and the one repetition maximum in the bench press test was determined for each subject. On 6 separate occasions, subjects performed a 4 set of bench press at 60% 1RM with a 90 and 240 seconds rest interval until volitional fatigue. The numbers of repetition performed by the subjects, and also, cortisol and testosterone levels and 1RM were recorded. The results showed that there was a significant difference in the sustainability of repetitions during 4 sets bench press with 60 % load between 90 and 240 seconds rest intervals (rest interval effect) ($p<0.05$) as well as with 90% load. *Results:* Additionally, there was a significant difference in the sustainability of repetitions during 4 sets bench press in 90 and 240 seconds rest intervals, both, between light and heavy loads (load effect). Plasma cortisol concentrations significantly increased after all bench press trials. Also, the rest interval effect was statistically significant in both 60 % and 90% load trials. But, the load effect was only statistically significant in 90 seconds rest interval trial ($p<0.05$). In contrast, plasma testosterone concentrations significantly increased after 4 sets bench press only in 90 seconds rest interval with heavy load and 240 seconds rest interval with light load ($p<0.05$). Accordingly, testosterone to cortisol (T:C) ratio were significantly decreased after 4 sets bench press in 90 seconds rest interval with light load and 240 seconds rest interval with heavy load. Also, load effect was statistically significant only in 90 seconds rest interval trials and rest interval effect was statistically significant only in heavy load trials ($p<0.05$). *Conclusions:* Based on these results it can be concluded that when resistance training with light loads, higher resting interval (240 seconds) may be provides a better anabolic environment for muscle growth and keep the training intensity.
Key words: rest interval, training load, resistance training

Introduction

In recent years, one of the important issues that have attracted the attention of many researchers is the optimum recovery time in exercise training and sports competition. Due to the nature of the sports and different needs of fitness, there is a specific training method for obtaining the necessary preparations for any sport [4]. Among the training factors, the rest interval time between workouts is a key element of success in any training program [3].

Recovery or return to the base state is the time between the end of a workout or strenuous activity and the next activity or in other words, the duration between the end of one activity and the start next break [15].

Due to the great diversity of sports, the optimal recovery time varies between different fields. Therefore, athletes should train with different methods based on the nature of their sport and the need for strength, endurance and speed.

Weight training in many sports is important for improving physical fitness factors. Hence, athletes to achieve the desired level of performance and increase overall physiological abilities, should use strength-endurance training. According to many studies in the past two decades, rest interval and a proper recovery time between activities is one of the main factors for the success of any training program [6, 15, 17]. In the absence of adequate rest and recovery, athletes will not benefit from the full effect of exercise.

There has been enough information about the optimal weights, repetitions and sets in weight training programs. Much research was done in the area of weight training based on principles of overload, resistance and features. De Salles et al (2009) studied the rest interval between sets in strength training [6]. They reported that resting 3-5 minutes between sets produced greater increases in absolute strength, due to higher intensities and volumes of training. Furthermore, they reported that higher levels of muscular power were demonstrated over multiple sets with 3 or 5 minutes versus 1 minute of rest between sets. Jensen and Ebben (2003) studied the kinetic analysis of complex training rest interval effect on vertical jump performance [9]. They showed that to optimize jump performance it appears that athletes should not perform jumps immediately following resistance training. It may be possible that beyond 4 minutes of recovery performance could be enhanced. Robinson et al (1995) investigated the effects of different weight training exercise/rest intervals on strength, power, and high-intensity exercise endurance [20]. They showed that except for maximum strength, adaptations, to short-term, high-volume training may not be dependent on the length of rest intervals. Matuszak et al (2003) studied the effect of rest interval length on repeated 1 repetition maximum back squats [13]. They reported that indicate that 1-minute rest intervals are sufficient for recovery between attempted lifts during 1RM testing or training for the free-weight back squat when involving lifters of this caliber. Willardson et al (2006) investigated the effect of rest interval length on bench press performance with heavy vs. light loads [25]. They showed

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that when the training goal is the maximal strength development, 3 minutes of rest should be taken between sets to avoid significant declines in repetitions. The ability to sustain repetitions while keeping the intensity constant may result in a higher training volume and consequently greater gains in muscular strength. Rahimi (2005) studied the effect of different rest intervals on the exercise volume completed during squat bouts [17]. He reported that the 5-minute rest condition resulted in the highest volume completed, followed in descending order by the 2- and 1-minute rest conditions. The ability to perform a higher volume of training with a given load may stimulate greater strength adaptations.

In recent years, several studies have examined the effect of exercise loads, number of repetitions and sets discussed. However, there is no general consensus about rest periods between sets. Furthermore, the period of rest between weight training sessions are different in strength and endurance sports. Therefore, the purpose of the present study was to determine the appropriate rest time between sets during weight training with light load.

Methods

Subjects

Seventeen cadet wrestlers were recruited from wrestling clubs in the Iranian province of Kurdistan and served as subjects in this study. They all had at least 3 years training experience and were representative of the top wrestlers of Kurdistan competing in national competitions. Before participating, the subjects' parents were informed of the potential risks and gave their written informed consent for their children to participate in this study, which was consistent with the human subject policy of the University of Guilan Research Center. Subject characteristics were as follows (mean ± SD): age =16.7±0.6 yr; height =169.2±8.2 cm; and weight =51.4±7.9 kg.

This study was conducted over seven sessions with 48 hours recovery between sessions. In the first session, the characteristic features of subjects were recorded and the one repetition maximum in the bench press test was determined for each subject. On 6 separate occasions, subjects performed a 4 set of bench press at 60% 1RM with a 90 and 240 seconds rest interval until volitional fatigue.

The numbers of repetition performed by the subjects were recorded. 5 ml blood was drawn from the antecubital vein before and 5 minutes after exercise and transferred immediately to the lab for assessing blood testosterone and cortisol levels. Serum levels of testosterone and cortisol were measured by radioimmunoassay (RIA) using the commercial kit (IM1119, IMMUNOTECH) and (IMMUNOTECH, IM1841). The one-repetition maximum (1RM) of subject measured by bench press test and Brzycki formula:

$$1RM=\text{weight (kg)} \times (1.0278-(0.0278 \times \text{repetition}))$$ [18].

Statistical Methods

All descriptive data are expressed as means ± SD. Data were analyzed using ANOVA with repeated measure and Bonferroni post hoc test. Statistical analysis was conducted using SPSS 16.0 for Windows.

Results

The results of sustainability of repetition, Cortisol concentrations, Testosterone concentrations, and Testosterone to Cortisol (T: C) ratio during 4 sets bench press in different trails are shown in Fig 1. There was a significant difference in the sustainability of repetitions during 4 sets bench press with 60 % load between 90 and 240 seconds rest intervals ($p<0.05$; Fig 1-A).

Plasma cortisol concentrations significantly increased after both bench press trials. Also, the rest interval effect was statistically significant in 60 % load trial ($p<0.05$; Fig 1-B). In contrast, plasma testosterone concentrations significantly increased after 4 sets bench press only in 240 seconds rest interval with light load ($p<0.05$; Fig 1-C). Accordingly, testosterone to cortisol (T:C) ratio were significantly decreased after 4 sets bench press in 90 seconds rest interval ($p<0.05$; Fig 1-D).

Discussion

One of the experimental methods to evaluate the physically and mentally state of athletes is the investigation of the anabolic and catabolic hormones changes during exercise. In this context, the role of cortisol as a primary catabolic hormone is important. It has been suggested that cortisol changes in response to exercise and, mental and physical stress [12].

Our results showed that plasma cortisol concentrations increased significantly after 4 sets bench press exercise with 90 and 240 seconds rest intervals between sets with light and heavy loads. Interestingly, mean changes were significantly higher in 90 seconds rest interval with 60% load in compare to 90% load.

It is reported that changes in core temperature during exercise can affect plasma cortisol levels and there is a direct correlation between core temperature and cortisol levels [5]. Furthermore, other researchers showed that exercise is a powerful stimulant for the central nervous system (CNS) and hypothalamic-pituitary-adrenal axis [1].

Moreover, other authors reported that increase in core temperature during exercise via stimulating hypothalamic-pituitary-adrenal axis increases cortisol values [23]. If you don't get sufficient rest between workouts, this hormone will change in a way that puts your body in a catabolic state. Cortisol is a catabolic and steroid hormone which is largely involved in regulation of metabolism and the body's response to exercise stress. However, long-term elevation will cause the problems that immune system disorders and protein degradation are most important of these [24].

Cortisol changes during exercise training are explained by different mechanisms. In the high intensity exercise, a 2-fold increase in plasma cortisol is observed, which is due to the increased hormone secretion rather to the excretion [10].

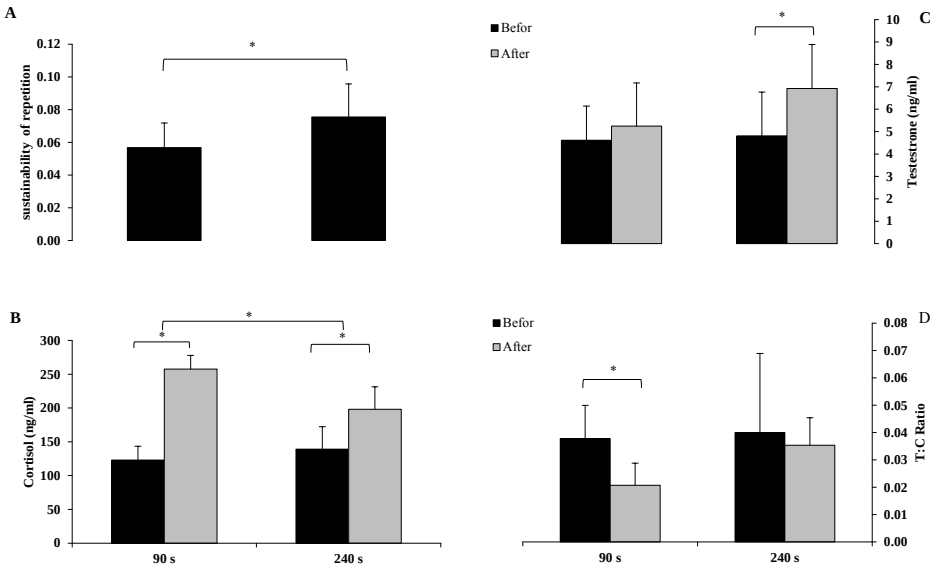

*Fig 1. Means and standard deviations of (A) Sustainability of repetition, (B) Cortisol concentrations, (C) Testosterone concentrations, and (D) Testosterone to Cortisol (T:C) ratio, during 4 sets bench press in different trails. *, Significant difference between line-delineated trails; p<0.05.*

The intensity and duration of physical activity are important factors that affect cortisol response. In the exercise with intensity of higher than 60 % maximum oxygen consumption, the levels of this hormone is increased [10].

Although, more increase in cortisol level in 240 seconds in compare to 90 seconds rest interval is unaccountable in heavy load trials, using light load, lower the rest interval resulted in higher cortisol levels in current study. Many factors such as stress, physiological circadian rhythm and body temperature affects on the acute cortisol response to exercise [10].

We observed that mean plasma testosterone concentrations do not change significantly after 4 sets bench press with light load and 90 seconds rest interval, as similar as, with heavy load and 240 seconds rest interval. In contrast, as mentioned above, cortisol level has significantly increased in these trials. Since cortisol is the inhibitor of testosterone secretion and the level of this hormone increased, it is expected that in this rest intervals, testosterone does not change significantly [7].

On the other hand, it is known that skeletal muscle fibers have specific androgen receptors that can remove these hormones from the circulation and cleansing by the increase in the metabolism of these. Therefore, in the present study, may be increased removal of testosterone by muscle result in increased insignificant testosterone [2, 21].

As a result of cortisol and testosterone changes, the testosterone to cortisol ratio, a criteria for balance of anabolic-catabolic processes [14, 22], significantly changed in those trials that testosterone has no significant changes, i.e. light load with 90 s rest interval and heavy load with 240 s rest interval.

Mechanisms underlying testosterone changes following physical activity is not well understood. However, one of the possible mechanisms that proposed for testosterone changes is shifts in blood volume [16]. If blood volume reduced during physical activity is likely that increased blood viscosity and increase's hormone was unreal.

Based on the intensity and duration of physical activity, temporary changes occur in the balance of anabolic-catabolic processes. Repetitive exercises without adequate and appropriate recovery can cause prolonged irregularities in the balance of anabolic-catabolic processes [8, 11]. Furthermore, this ratio decreases with increasing intensity and duration of exercise [8].

The results showed that the testosterone to cortisol ratio has significantly changed after 4 sets of bench press with 90 seconds rest interval. Although, increased the levels of testosterone and cortisol, both, the testosterone cortisol ratio was significantly reduced due to higher levels of cortisol in compare to testosterone.

Finally, the ability to maintain repetitions of bench press is higher in long vs. short rest intervals. It is possible that insufficient time for recovery and reconstruction energy stores and waste disposal in the short rest intervals is the main cause. It can be concluded that in the situations that muscle hypertrophy is a goal; it can be obtained by assigning a long time rest interval and heavy load in resistant exercise training.

Overall, the results indicated that the Sustainability of repetition, Testosterone concentration and testosterone to cortisol ratio in training with light load and rest intervals of 240 seconds was more than 90 seconds. Also, the cortisol concentration in 240 seconds resting interval was less than 90 seconds resting interval. Based on these results it can be concluded that when resistance training with light loads, higher resting interval (240 seconds) may be provides a better anabolic environment for muscle growth and keep the training intensity.

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