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Effects of high intensity interval training on plasma levels of growth hormone and insulin like growth factor-1 in healthy males

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ABSTRACT

It is well-recognized that exercise has a significant impact on the growth hormone / insulin-like growth factor GH/IGF system but less is known about the effects of high intensity training (HIT) on this axis. Aim of the present study was to evaluate the effect of ten weeks of HIT on plasma levels of GH and IGF-I in healthy men. Twenty young men (age 23.34±2.56 weight 72.47±12.01 height 174.10 ± 5.75) recruited and randomly assigned into Control (n=10) and HIT (n=12) groups. HIT protocol was started with 4 cycles. Then, every two weeks one cycle was added to the previous ones. Finally it was to 8 cycles/session in tenth weeks that lasted 16 minutes. Blood samples were collected prior to and after HIT program for all subjects and IGF-I and GH levels were measured. HIT subjects showed a significant increase in IGF-I (P=0.002, F=12.38). However no significant change was shown in GH levels (P=0.716, F=0.62).Our findings indicate that the HIT caused increase in circulating levels of IGF-I independently from GH levels. Both hormones may contribute to positive effects of anabolic conditions.

KEY WORDS: IGF-I/GH AXIS, HIT, ADAPTATION

INTRODUCTION

Growth hormone (GH) is the principal regulator of the hepatic synthesis of insulin-like growth factor I (IGF-1). IGF-1 itself is the primary downstream mediator of GH actions, and circulating IGF-1 plays an important role in the feedback regulation of GH secretion. However IGF-1, produced in skeletal muscle during exercise, is also released into the circulation which might explain an increase in Circulating IGF-1 levels as well Frystyk (2010) and Nindl (2010). IGF-1 has widespread anabolic and insulin-sensitizing effects, and plays a critical role in formation, maintenance, and regeneration of skeletal muscles. IGF-1 also plays a direct role in whole body glucose homeostasis primarily by stimulating skeletal muscle glucose uptake (Berg and Bang 2004).

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Nindl et al. (2010) stated that IGF-1 is an important metabolic biomarker associated with a variety of health and exercise-related outcomes. It is well-recognized that exercise has a significant impact on the GH/IGF system, number of factors have led to interest in the effect of exercise on the growth hormone/insulin-like growth factor-I (GH/IGF-I) axis, including its possible role in maintenance of lean mass in a variety of physiological actions like protein synthesis, cellular proliferation and glucose metabolism, (Brill et al., 2002 and Weltman et al 2003).

Although most modes of exercise stimulate an increased GH secretory response that is linear with exercise intensity evidence suggests IGF-I responses are independent of GH. Insulin-like growth factor I (IGF-1) is a polypeptide of 70 amino acids (7650 daltons), and is one of a number of related insulin-like growth factors present in the circulation.The molecule has a number of biological activities similar to insulin. IGF-1 concentrations change with age, nutritional status, body composition and physical activity, m(Roy et al 1985, Hornum et al 1985, Stitt et al.2004).Whether previous studies have reported exercise-induced alterations of IGF-I seems to depend on several factors, including exercise model. Both low- and high-intensity cycling have been shown to increase IGF-I concentrations. However, neither low-volume nor high-volume resistance exercise has been shown to change total IGF-I concentrations, (Cappon et al., 1994 and Nindl et al., 2001).

Moreover, no change in IGF-I concentrations has been found following a marathon, a 20 km run, and treadmill exercise at 60% of Vo max. The ability of IGF-I to promote muscle hypertrophy is unchallenged; however, several lines of evidence have demonstrated that load-induced hypertrophy can occur independently of IGF-I and/or activation of the IGF-I receptor. Conversely, evidence in support of IGF-I as a "regulator or amplifier" of muscle remodeling cascades also exists, (Hagberg et al., 1988, Banfi et al., 1994, Spangenburg et al., 2008 and Flueck and Goldspink 2011).

HIT exercises are high intensity and interval that can be done in a short time, although has the benefits of long-term endurance exercise. Even though the recent studies have shown endurance training can induce an increase of GH, IGF-1, levels in the circulation, but less is known about the effects of different training intensities (e. g. high-intensity training (HIT) on circulating levels of these growth factors. Only a few studies have addressed this issue in a strictly experimental way. The purpose of the present study was to evaluate the effect of ten weeks of HIT on plasma levels of GH and IGF-I in healthy men. The present study differs from previous studies, the protocol was more rigorous and exercise responses were compared with a non-exercise control trial, (Schwarz et al 1996 and Laursens and Jenkins 2002).

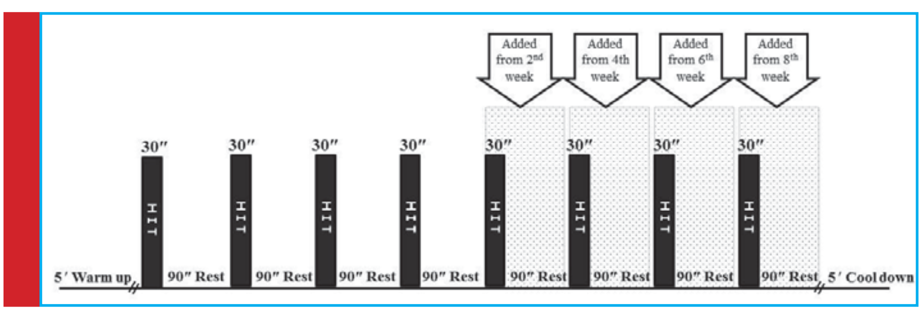
METHODS

STUDY DESIGN /PARTICIPANTS

Trial design was semi-experimental with control group. Twenty two young men (age 23.34±2.56 weight 72.47±12.01 height 174.10 ± 5.75) recruited via a recall in Ferdowsi university of Mashhad campuses and those approved participation were randomized into either a training group (HIT) or a control group (CON). Informed consent was obtained from each patient included in the study and the study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki.Exclusion criteria include professional athletics history as well as the current regular exercise, smoking, cardiovascular and metabolic disease or any complication that disrupt the implementation of exercise.

HIT group after became acquainted with the correct training performances, carried out the exercises, every other day, three sessions a week, for 10 weeks. Exercises included warm up, HIT training, cool down. Subjects warmed up by stretching and easy walking for 5 minutes. The HIT interventions consisted of four 30 s maximal effort ("all-out") shuttle run bouts (from cone-1 to cone-2 ,20 meter sweep) separated by 1.5 min passive rest each (Fig. 1).

HIT protocol began with 4 cycles and every two weeks added one cycle. Finally it was 8 cycles in tenth week that lasted 16 minutes. Cooling Down also included 5



min of walking and stretching. During the HIT interventions all subjects were vocally encouraged to maintain Maximal effort. Quality of training was controlled by a physical education expert and subject's heartbeat was constantly checked by polar device. Control group asked to be sedentary in this period.

Twenty four hours before starting the exercise program, while all the subjects were fasten; 5 cc of blood was taken from their brachial vein. Also sampling repeated after 48 hours of last session in same condition. Blood samples were frozen in -20 for future analysis. LDN (Germany) ELISA assay Kit was used to measure IGF-I concentrations which Sensitivity was 1.292 ng / mL and monobind (USA) ELISA assay Kit was used to measure GH concentrations which Sensitivity was 0.072 ng /mL.

Data normality was tested using Shapiro-wilk and the homogeneity of the variances was tested using levene. After making sure of the normality and equality of the groups, variance analysis with repeated measuring was used to study the differences between groups. Statistical analysis was done by the SPSS Software.

RESULTS AND DISCUSSION

After ten weeks HIT subjects showed a significant increase in IGF-I ($P=0.002$, $F=12.38$). However no significant change was shown in GH levels ($P=0.716$, $F=0.62$). (Table 1).

Previous studies have been reported that exercise has a significant impact on the levels of several hormones, and can increase resistance and performance, as well as muscle mass. Hormone levels can change according to several parameters, including the type and length of exercise, the duration of time following exercise, the age and gender of the athletes, among others, Kraemer et al (2006). Based on the findings from the present research, plasma levels of IGF-I had been significantly increased due to HIT protocol. To our knowledge, no previous research has directly investigated the impacts of HIT on IGF-I/GH axis. However, other types of training have been published. Most of the training time during the HIT intervention was spent in recovery between short, intense bursts of all-out shuttle running. This is in accordance with previously published studies, (Wahl et al 2010).

Several studies have indicated that anabolic hormones, such as insulin, GH, testosterone and IGF-1, stimulate neural tissue and muscle development during resistance exercise, (Crewther et al 2006). The serum concentration of anabolic hormones is elevated during and following resistance exercise compared to the level at rest, which leads to hypertrophy and remodeling of muscle (Widdowson et al., 2009). Circadian rhythm has specific effects on the release of IGF-1 in the body, where the hormone levels are higher in the morning and lower in the afternoon, (Hayes et al., 2010).

In the present study GH concentrations did not significantly changed as a result of relative long term HIT. That regard should be considered that due to our study limitation, GH only measured at one point in time. Also regarding Circadian rhythm and the pulsatile manner of GH it will probably cause different results when compared with multi-time point, whereas long-term exercise training approximately doubles integrated GH concentrations when measured on non-exercising days. Linnamo et al. reports that GH levels are increased in response to submaximal and maximal heavy resistance exercise. However, the prominent increase was detected just after the exercise session was completed, and the response returned to normal level two hours post exercise, (Weltman et al., 1992 and Linnamo et al., 2005).

Different training intensities, such as high-intensity training and high volume, low-intensity training may have a different impact on hormone levels. Although pH is generally well regulated, a more increase in the acidity of the circulating blood and the skeletal muscle occurs when performing HIT. One can speculate that these systemic and local changes in the extracellular environment might influence the release, the affinity, and association/ dissociation of GH, IGF-1. The extracellular pH has been recognized to regulate the IGF-1 interactions with different cells, components of the extracellular, (Gordon et al 1994 and Gibala et al 2006).

Table 1. Study variables before (pre) and after (post) 10 weeks of study protocol

Variable	Control		HIT		ANOVA (Repeated Measurement)
	Pre test	Post test	Pre test	Post test	
IGF-I (ng /mL)	193.10± 33.54	190.60 ± 32.32	199.27 ± 28.69	222.27 ± 32.90	F=12.38 P=0.002
GH (ng /mL)	3.053±0.73	3.004±0.53	3.241±0.41	3.158±0.61	F=0.62 P=0.716

Data are mean ± SD

In summary, we undertook a randomized trial of the impact of 10 weeks of HIT on IGF-I/GH axis in previously untrained subjects. The major finding was HIT caused increase in circulating levels of IGF-I independently from GH levels. Both hormones may contribute to the positive effects of anabolic conditions as it has been shown by previous studies.

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