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Plasma Growth Hormone and Prolactin Levels in Healthy Sedentary Young Men after Short-Term Endurance Training under Hot Environment

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A B S T R A C T

Pituitary hormones play an important role energy expenditure and body temperature regulation during exercise. The aim of the study was to investigate the effect of two different endurance training in ambient temperature (30.76 ± 1.71°C and 57.92 ± 5.80% r.h.) on plasma growth hormone (GH) and prolactin (PRL) levels in non-trained healthy subjects. Twenty-four untrained healthy men participated in an 8-wk progressive two different endurance-training program. Subjects were divided into two groups: an interval running group (IR), and continuous running group (CR). Both groups were performed 3 days/wk. Growth hormone, PRL and VO_{2max} *levels were assessed at the beginning and the end of the training period. Body temperature (*T_B*) was also measured at the beginning and immediately after each training. The exercise type affected plasma PRL (8.52 vs. 6.50 ng/ml IR and CT groups,* $P < 0.02$*) but did not alter plasma GH levels (0.95 vs 0.63 ng/ml IR and CT groups,* $P>0.38$*). Plasma GH level at the end of training program increased from 0.42 to 1.48 ng/ml and 0.58 to 0.67 ng/ml for IR and CR groups. Expectedly, both training types increased* T_B*, at a greater rate for IR group than CR group. In conclusion, an 8-wk regular exercise result in an increase in plasma PRL level, without altering plasma GH level, which accompanied by elevated body temperature, regardless of the individual's sporting routine. These suggest that untrained individuals could benefit from a regular exercise program as much as those doing the routine sport.*

Key words: *GH, PRL, hot temperature, endurance training.*

Introduction

Humans are homoeothermic, which means that internal body temperature is physiologically regulated to keep it nearly constant even when environmental temperature changes[1]. Physical exercise and elevations in environmental temperature are each strong stimuli that can affect both the sympathetic nervous system and the hypothalamic-pituitary-adrenocortical axis[2,3]. Growth hormone , which is a potent anabolic, influences all systems of the body and has an important role in the development of muscles. Anterior pituitary hormone, prolactin, is used as an indirect indicator of central fatigue when exposed to heat actively[4]. During exercise, the organism is exposed to overload compared to what is encountered during the daily life[5]. Body temperature rises during these overloads. The capacity for prolonged exercise is diminished in hot environments relative to normothermic conditions[6,7]. Humans have evolved to tolerate a wide range of environmental temperatures while keeping the body's core temperature within rather narrow limits[8]. Most hormones released during exercise are increased in plasma also during the heat exposure[9,10].

It has been generally known that heavy resistance exercise has a potent effect in promoting increases in size and strength of skeletal muscle. The effect of training on the GH response to acute exercise is uncertain with different results being reported. Possible reasons for these discrepancies are: (i) differences in exercise duration and severity (ii) individual nutritional and hormonal status; (iii) technical differences in assay protocols (iv) adaptation to training[11]. At rest, GH secretion is pulsatile and is influenced by age, gender, nutrition, sleep, body composition, fitness, and sex steroid hormones[12]. During a 24-h period, spontaneous GH secretion is maximal at night in close association with slow wave sleep[13,14].

Few studies have assessed the effect of period of the day on the GH and cortisol responses to exercise. Two studies reported no effect of period of the day on the GH response to exercise[12]. The pituitary hormone response to such exercise is often described as a 'stress response' and, as such, implies a common mechanism for stimulating the release of several different hormones. Most hormones released during exercise are also increased as the result of passive heat exposure[15] and the idea of a role for body temperature in the control of hormone release during exercise has been supported by a number of studies[16, 17]. Prolactin release from the anterior pituitary gland occurs in response to raised core body temperature both as a result of exercise and passive heating[18]. Growth hormone concentrations increase as a result of exercise and the extent is governed by exercise intensity[19] and has been reported to be linearly related to core temperature during exercise[20]. Prolactin release during exercise[21], has shown differences in the relationship between prolactin concentration and rectal temperature in hot and cool conditions. The aim of the study was to investigate the effect of two different endurance training in ambient temperature (30.76 ± 1.71°C and 57.92 ± 5.80% r.h.) on plasma growth hormone

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(GH) and prolactin (PRL) levels in non-trained healthy subjects.

Materials and Methods

General design

Subjects performed two exercise training period to investigate the effect of different endurance training methods on plasma GH and PRL levels at ambient temperatures of 30 °C and 60% r.h. Blood samples were collected pre and post training periods and T_B were measured before and immediately after each training.

Subjects

Twenty-four (n=12 IR, n=12 CR) untrained healthy university student participated in the study. Their physical characteristics (mean ± SD) were: IR; age, 24,27 ± 2,71 yr; ht, 1,75 ±,06 cm; body mass, 74.5 ± 3.4 kg; VO_{2max}; 32.45±6.4 ml kg−1 min−1 and for CR; age, 22.73±3.51 yr; ht, 1.73 ± 0.06 cm; body mass, 71.9 ± 2.7 kg; VO_{2max}; 31.93 ± 4.7 ml kg−1 min−1.

Experimental design

IR group was performed interval running. First 2 wk one set that included 250 m, 400 m, 650m ant 900 m running 1min jog between each running distance, from 3rd wk till 7th wk two set and last two wk three set at the intensity of 60 - 80 % target heart rate. CR group performed running exercise from 25 to 60 minutes for 3 days a wk, at the intensity of 50-70% target heart rate that was calculated by Karvenon method for each subject.

Before the exercise-training program: On the day of a test, subjects arrived at the test area at 08.00 h having fasted from midnight. Each subject participated in two randomized experiments separated by interval or continuously running group. Blood samples were taken for determination of pre-exercise values of hormones than shuttle-running test began to measure of the VO_{2max}.

Body temperature (T_B) measurements: Before and immediately after each training session, the T_B was measured with BRAUN IRT-4520 Thermoscan and recorded. Subjects did not drink water during exercise training.

After the exercise training program: Finally the last measurements were performed and blood samples withdrawn for determination of post-exercise values of hormones than shuttle running test was made to measure of the last $VO_{2max.}$

Blood analysis

Blood samples were taken from all subjects at rest at the start of the study. Samples were again taken at eight wk at maximal exercise performance. The blood was collected from the antecubital vein into sterile test tubes. The tubes were centrifuged at 4500 rpm for 10 min at 4˚C for separation of the serum, which was frozen to -80˚C until needed for analysis. Growth hormone and PRL concentrations were measured by using IMMULITE 2000 analyzer with chemiluminescence method (Skybio Ltd, UK).

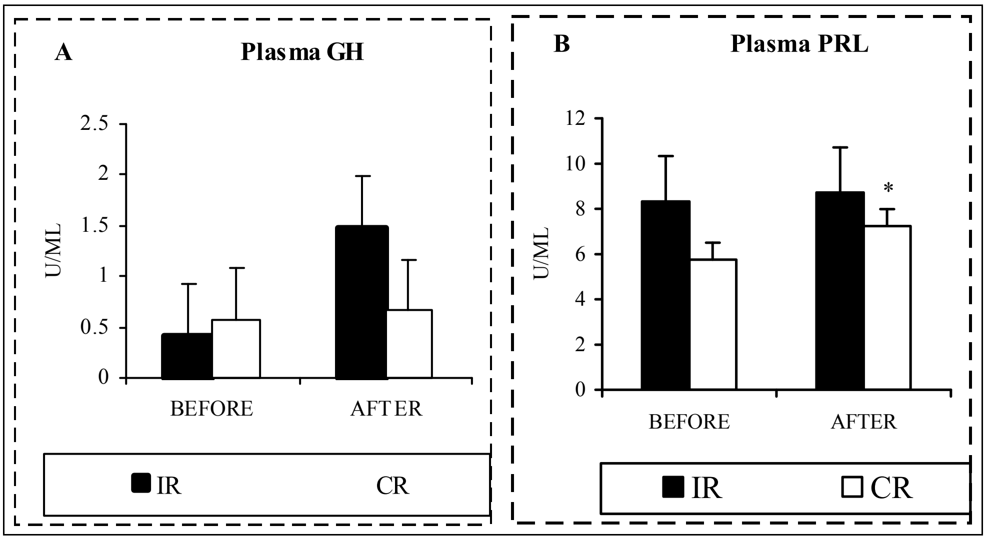
Statistical Analysis

The effect of endurance trainings on GH, PRL, T_B and VO_{2max} were tested before and after training by 2-way ANOVA using the GLM Procedure (SPPS, ver. 11.5.0, Chicago, IL, USA). The linear model included the effect of training and time relative to training and their interaction. Statistical significance was declared at $p<0.05$.

Results

In an environment in which the average temperature and humidity ratio are respectively 30.76 ± 1.71°C and 57.92 ± 5.80% r.h., the effects of exercise on the parameters are as follows.

Interval Running Group (IR): The interval endurance training-induced increase of body temperature was higher after training periods and this was significant ($P<0,05$).



Legend: GH= Growth Hormone, PRL=Prolactin, IR = Interval Running Group, CR= Continuous Running Group.

FIGURE 1

PLASMA GH AND PRL LEVELS 8 WK TRAINING PERIOD UNDER HOT ENVIRONMENTS (30.76^{O}C AND 57.92% R.H.). SIGNIFICANT DIFFERENCE IS BEFORE AND AFTER FOR PRL (*$P<0.02$).

TABLE 1
COMPARISION TWO DIFFERENT RUNNING PROGRAM

Variable	Exercise type				SEM	Effects, P <		
	Interval		Continuous					
	Before	After	Before	After		E	T	ExT
GH, ng/ml	0.42	1.48	0.58	0.67	0.368	0.38	0.13	0.19
PRL, ng/ml	8.33	8.72	5.75	7.24	0.85	0.02	0.28	0.52
TB °C	36.05	36.47	35.85	36.47	0.03	0.0001	0.0001	0.0001
VO2max	32.45	45.93	31.93	45.63		0.0001	0.75	0.93

Legend: GH=Growth Hormone, PRL=Prolactin, T_B= Body Temperature, E= Exercise,
T= Time, ExT= Exercise and time of the test.

Continuous Running Group (CR): The continuous endurance training-induced increase of T_B was higher after training periods and this was significant (P<0,05).

Discussion

The stresses of physical exertion often are complicated by environmental thermal condition[1]. In the following discussion, we focus on the endocrinology responses to short- term training period in hot environments.

The aim of this investigation was to compare the GH, PRL and cardiovascular responses during different endurance training methods. The present study showed that both endurance training method (interval and continuous) cause an increase at V_{O2max}. Endurance training was chosen as a model of exercise to observe the developing of V_{O2max}. Because common goal of this type training method is to increase of V_{O2max}. This goal was achieved with both methods after the training period.

Growth Hormonu: The effects of exercises performed in different environments have been the subject of many researches from past to present. If we take a look at the results of previous studies; Buckler[22] observed that GH increased due to the rise in temperature as a result of 20 minutes of exhaustive exercise that is performed at 4°C and 21°C; Christensen with his collaborators[23] observed that GH decreased and GH increased at 22°C, though there was a rise in the body temperature during an exercise of intermediate level that was performed at 4°C. Cross-with his collaborators[24] demonstrated that, in a 40 minutes of exercise performed with 65% VO_{2max}, increase in both body temperature and GH was observed at 23°C, however, this increase was observed as 2 times more at 39°C.

Hot environment and exercise result in changes by effecting the hormone regulation of the organism through central nervous system. If the adaptation mechanisms of a person exposed to this situation can demonstrate the necessary concordance. Otherwise, many healths related problems arise. For example, Frewin with his collaborators[25] showed that, the rising body temperature at 10°C during a treadmill exercise of 20 min. did not change the GH level; however, the same exercise resulted in an increase of 426% in GH at 40°C.

Exercise intensities effect these changes to a large extent. Raynaud with his collaborators[26], performed bicycle ergometry exercise at 24°C and 33°C at different intensities (47-59-70%). As a result, increase in GH and T_B was recorded in all exercises with increasing intensity except for the one performed at an intensity of 47%.

The new observations are that while GH release during the first 30–40 min of exercise shows a close relationship with rising rectal temperature, unlike prolactin, this relationship was similar in hot and cool conditions[27]**.** Wee with his collaborators[28] stated that exercise increased GH release, however Vigas with his collaborators[29], suggested that the rise in plasma GH levels were not due to exercise, contrarily it might be due to the increased T_B, and Armstrong and Hatfield[30] stated that GH levels might increase due to stress that forms with the increase at the temperature of the environment.

Performed studies are rather related to the reactions given to the acute exercises performed in hot environment. Wheldon[31] stated that swimming exercise at room temperature increased GH level. However, the hormonal response that the body gives due to thermoregulation after a short and long period of exercise is important. In the presented study, a significant rise in GH as a result of stamina exercises at increased pace for 8 wk was not observed. In this case, if GH does not increase though average environmental temperatures and humidity rate's being 30.76 ± 1.71^{o}C and 57.92 ± 5.80% r.h, respectively, increase in T_B, and increase in exercise intensity, then the most important reason for this is acclimatization. Acclimatization only occurs with regular exercise. With regular exercises performed in hot environment, our body adapts physiologically and decreases the negative effects of temperature

Secretion of plasma GH depends on different reasons like type of exercise, body temperature and age. In present study, increment in GH level was higher in IR group than that of CR group who trained at same environmental temperature. Ftaiti[32] indicated that exercise done in hot environment was much more effective to increase of GH level. Although Vigas with his collaborators[16] reported that increment in body temperature during exercise triggered GH secretion, in present study, increased body temperature did not did not significantly effect GH level, also the results of the study done by Tamer[33] supported our results.

Prolactin: Previous observations concerning the release of prolactin when exercising in hot and cool environments, indicating that ambient temperature has a major effect in modulating the response[34].

As in GH, PRL also changes due to various reasons. Some of them are the water level and temperature of the body. After exercise with different levels of water given to sportsmen/sportswomen, plasma PRL levels were determined to be at higher values at the 40th and 60th minutes of the exercise. The reason for this increase was attributed to increased body temperature.

Paez with his collaborators[35] found a significant increase in PRL level after a 100 m. free style swimming exercise. Meeusen with his collaborators[36] detected that there was a 14% increase in PRL levels in cyclers who had performed excessive exercise. In another exercise, according to the results of exercise performed in environments of different temperatures, body temperature may be a stimulus for the GH and PRL release[37]. In healthy people kept inside the water at 38-39^{o}C for 25 minutes without exercise, a slight increase in body temperature and GH and decrease in PRL were observed[38].

The core temperature and PRL responses between the pre and post interval and continues training period were not correlated. Much investigation has shown that increases in PRL at exhaustion are significantly related to core temperature and ratings of perceived exertion at exhaustion during prolonged exercise in hot conditions[39,40].

Within the program, sportsmen performing continuous running were observed to be more exhausted. Our results indicate that release of prolactin plays a role to show exhaustion in the sportsmen.

The level of plasma PRL hormone significantly increased in CR group. As Low with his collaborators[41] claimed that, the reason of increment in PRL hormone level during endurance exercise that is used as a sign in central fatigue could be continuous stimulations sent by central nervous system. Though Burk with his collaborators[42] reported that the maxVO_2 accepted as the other increase PRL hormone level, we can not say same thing for this study because there was no significant difference among maxVO_2 level of both group. Consequently, continuous running can be assumed as the reason of increase in PRL hormone level.

Conclusion

In conclusion, an 8-wk regular exercise result in an increase in plasma PRL level, without altering plasma GH level, which accompanied by elevated body temperature, regardless of the individual's sporting routine.

Our results show that 8 wk endurance training under hot environment was not the stimulus for growth hormone release. On the other hand, continuously running at same environment was stimulus for prolactin hormone release.

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NIVOI PLAZMINOG HORMONA RASTA I PROKLATINA KOD ZDRAVIH SEDENTARNIH MLADIH LJUDI NAKON KRATKOTRAJNOG TRENINGA U TOPLOM OKRUŽENJU

S A Ž E T A K

Hipofizini hormini imaju važnu ulogu u potrošnji energije i regulaciji tjelesne temperature tokom vježbanja. Cilj istraživanja bio je da se ispita uticaj dva različita treninga izdržljivosti u sobnoj temperaturi (30.76 ± 1.71oC i 57.92 ± 5.80% r.h.) na nivo plazminog hormona rasta (GH) i proklatina (PRL) kod neobučenih zdravih ispitanika. Dvadesetčetvorica neobučenih zdravih muškaraca učestvovali su u dva različita osmonedjeljna progresivna programa treninga izdržljivosti. Učesnici su bili podijeljeni u dvije grupe: grupu koja je povremeno trčala (IR), i grupu koja je neprestano trčala (CR). Obije grupe su izvodile vježbe 3 dana nedjeljno. Nivo hormona rasta, PRL-a i VO2max procjenjivan je na početku i na kraju perioda treniranja. Tjelesna temperature (TB), takođe je mjerena na početku svakog treninga i odmah nakon istih. Ovaj tip vježbe uticao je na plazmin PRL (8.52 naspram 6.50 ng/ml IR i CT grupe, $P < 0.02$) ali nije mijenjao nivoe plazminog GH (0.95 naspram 0.63 ng/ml IR i CT grupe, $P>0.38$). Nivo plazminog GH na kraju programa treniranja povećao se od 0.42 do 1.48 ng/ml i od 0.58 do 0.67 ng/ml za IR i CR grupe. Kao što je očekivano, oba tipa treninga povećala su TB, pri čemu je rast bio veći kod IR grupe nego kod CR grupe. Zaključeno je da je osmonedjeljno redovno vježbanje rezultiralo porastom nivoa plazminog proklatina, ne mijenjajući nivo plazminog hormona rasta, što dalje prati povišena tjelesna temperatura, bez obzira na sportske rutine pojedinca. Ovo nagovještava da neobučeni individualci mogu imati koristi od redovnog programa treniranja u istoj mjeri koliko i oni koji rutinski treniraju.

Ključne riječi: hormon rasta, proklatin, visoka temperatura, trening izdržljivosti.