No Influence of Body Composition on Serum Growth Hormone Response to Acute Dynamic Exercise

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Abstract

Physical effort is a strong physiological stimulus that provokes an increase in blood growth hormone (GH) concentration. Interactions between GH and body composition are very complex. Seven athletes and seven age-matched controls completed a single 30-min bout of upright cycling exercise (5 % of VO_{2max}.) in order to estimate the influence of body composition on serum GH concentration during exercise. The serum GH concentration was measured in blood samples by standard immunoradiometric (IRMA) method. Anthropometric measurements were used for the calculation of body composition. There were no significant differences in total body mass or body mass index between the groups. The athletes had significantly less fat and higher bone and muscle mass. Serum GH concentration was 2.39 times higher in the athlets versus the control in the period of rest. During acute exercise, the serum GH concentration increased in both groups. No statistically significant differences between the groups in serum GH concentration were found either during the exercise or in the recovery. No correlation between body composition and serum GH concentration was found. Body composition depends on the level of physical activities but if the total body mass is in physiologycal range it does not influence the serum GH response to acute exercise.

KEY WORDS: growth hormone, body composition, athletes, young male

Introduction

Physical effort is a strong physiological stimulus that provokes an increase in blood growth hormone (GH) concentration (1,2,3). The precise mechanism of the increase in serum GH concentration during acute exercise as well as the role of GH in those conditions is still not completely understood. Results of the majority of studies (4,5) indicate that the increase in serum GH concentration during acute exercise is a result of action of multiple factors at hypothalamic level, which consequently cause the stimulation of GH releasing hormone and inhibition of somatostatine secretion or the inhibition of somatostatine secretion only. The dynamics of the increase in serum GH concentration during physical effort is influenced by age (6), gender (7), fat body mass (6,8), body composition (9,10), level of usual physical activities (4,11) as well as the intensity (1,2) and the duration of acute physical exercise. The influence of training as a chronic, programmed physical activity on hormonal response during acute exercise is due to change in range of "metabolic stress" caused by adaptation through the period of physical training (12). Interactions between GH and body composition are very complex (9). GH influences the tissue components of body mass, enlarging bone and muscle and reducing the fat mass through its effects on the metabolism of glucose, fats, and proteins (13). Particular components of body mass can indirectly regulate the secretion of GH. These interactive and very complex relationships are still under examination. The aim of this study was to estimate the influence of body composition on serum GH concentration in response to acute dynamic exercise in subjects with different level of physical activities..

Subjects and Methods

SUBJECTS

After providing written informed consent and the approval by the local ethics committee, 14 healthy, young male volunteers (21± 2,1 years of age) participated in the study. Seven of them were active athletes, three of whom were professional football players and four volleyball players, members of the national team. They were actively involved in programmed training in continuity for at least 3 year before this study. In the period before the study an average frequency of physical activities, training, was 4 to 6 times per week and 2 to 4 hours per single session. The control group involved seven healthy, age-matched subjects, medical students. All were normally active without additional recreational or programmed sport activities in continuity for at least 3 year before this study. Before participation, all subjects received medical examination and none of them showed any signs or symptoms of illness. In the study period they were not taking any medicaments.

METHODS

Body composition

Body composition was assessed by skinfolds method. The same investigator performed all anthropometric measurements on the right side of the subject's body. Harpenden skinfold caliper (10 g/mm constant pressure) was used for measuring skinfolds at subscapula, m. triceps, forearm, thigh, calf, abdomen. Repeated trials were performed until two measures within 1 mm were obtained; with the mean value of these two measures being used. Girth of limbs (upper arm - biceps, forearm, thigh and calf) was measured by standard measuring tape. Diameters of joints (elbow, wrist, knee and ankle) were measured by mobile measuring device. A six site skinfold equation by Mateigka (14) was used to determine proportional values of fat, muscle, and bone body mass. Body non-fat mass was calculated as the difference between total body mass and body fat mass.

Exercise test

During the first session all subjects performed continuous incremental upright cycling on a bicycle ergometer until volitional exhaustion for maximal oxygen uptake ($VO_{2\,max}$) measuring. Open-circuit spirometry (Q-PLEX) was used to collect metabolic data. The second session was completed two days after the first. The subjects performed single submaximal 30-min bout of upright cycling exercise (bicycle ergometer LODE - Corival 400) at about 65 % of the $VO_{2\,max}$, under the protocol of constant, continuous workload. Cycling cadence was 60 rpm. Before the test, chest electrodes were placed on the anterior thorax wall for the purpose of ECG heart rate monitoring. The subjects were requested to refrain from exercise, alcohol, caffeine and cigarette smoking for at least 24 h before the experimental trial. In the evening before the test (about 20.00 p.m.) they dined a meal consisting of 55% carbohydrates, 15% proteins and 30 % fat in order to avoid the influence of food on GH secretion during the test. After an overnight fast, no consumption of food, coffee, alcohol, medicines, or cigarette smoking was allowed before the test in the morning.

Blood sampling and analysis

Blood samples were collected from plastic cannula placed in the vein on the dorsal surface of the left hand ten minutes before the test. The samples were taken immediately before the exercise, during the exercise in 6 minutes intervals and 3 times in the recovery period (15th, 30th and 45th minute). Serum GH concentration was determined by standard imunoradiometric method (IRMA-immunoradiometric assay) (15). Reference values of serum GH for male subjects determined by this method are up to 10 mU/l.

Statistics

All results are expressed as mean ± SEM. The t-test for small dependent samples was used to determine the differences within the group, and Student t-test for differences between the groups. Significance threshold was set at $p<0{,}05$. The correlation was determined by Pearson's coefficient.

Results

Subject characteristics are presented in Table 1. There were no significant differences in total body mass or BMI regardless of the different level of physical activities between athletes and controls. Percentage of particular component of body mass is shown in Table 2. Fat body mass was higher in non-active, control subjects then in athletes ($p<0{,}04$) and non fat body mass and muscle mass were higher in athletes than in controls ($p<0{,}04$). Serum GH concentration are showed in Figure 1. The serum GH concentration in athletes was 2.39 times higher than in controls in the period of rest but the difference was not significant. At the end of the exercise, the serum GH concentration markedly increased compared with its level during the rest in both groups, $p<0{,}002$ in the athletes and $p<0{,}003$ in the controls. The value at the end of the exercise was 10 times higher in athletes (39,05 mU/l) and 22 times higher (35,47 mU/l) in control subjects compared with that during rest (3,77 mU/l in athletes and 1,58 mU/l in controls). During the recovery period values of serum GH concentration decreased successively compared with the values at the end of exercise in both groups. Concentration of GH in serum reverted to basal values 30 minutes after the end of exercise in the athletes and 45 minutes in the control group. There was no significant difference between serum GH concentration at the end of the recovery period compared with the value during the rest in both athletes and controls. No statistically significant correlation was found between fat, non-fat, muscle and bone components of body mass and serum GH concentration in the period of rest, during the exercise or the recovery period in both groups.

Discussion

The main results of our study are that higher level of physical activity influenced the relationships between particular components of body mass even if there was no difference in total body mass or BMI between athletes and controls. Acute exercise caused substantial increase in serum GH concentration that was not influenced by body composition. Although a large amount of information has been collected to describe these relationships, the basic mechanisms associated with them are not yet completely elucidated. Chronic physical activity causes morphological and specific metabolic adaptive changes. Among others, metabolic adaptation secures better uptake of energy substrate and more adequate response of the cardiovascular system in active

	Athletes	Control	p<
Height (m)	187,6±3,42	180,00±1,83	NS
Body mass (kg)	79,71±1,82	78,71±4,19	NS
BMI (kg/m^2)	22,52±1,30	24,17±0,83	NS

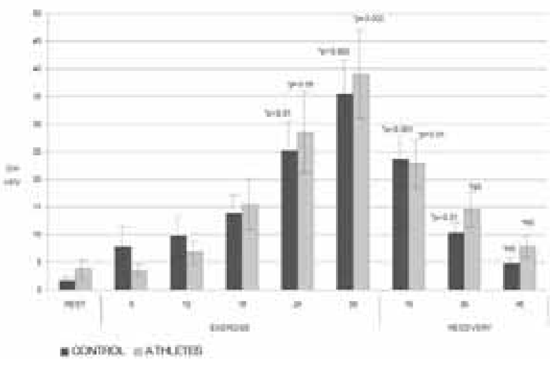
Data given as mean ± SEM

TABLE 1. Subject characteristics

	Athletes	Control	p<
Fat body mass (%)	10,84± 1,21	19,58±2,58	0,04
Non fat body mass* (%)	89,15±1,20	80,41±2,59	0,04
Muscle mass	38,62±2,24	35,24±1,53	0,04
Bone mass	14,24±0,71	12,32±0,31	NS

Data given as mean ±SEM
*The percentage of non fat body mass is given as a sum of percentage of muscle, bone and other (organs and body fluids)

TABLE 2. The components of body mass in athletes and controls



Data given as mean ±SE * Compared with value in the period of rest

FIGURE 1. Serum GH concentration in athletes (n=7) and in controls (n=7) in periods of rest, during exercise and in recovery period

subjects. Results of earlier studies showed an increase in serum GH concentration during physical activity. The reports on the magnitude of GH response during physical activity as well as the influence of the level of physical activity on that response are inconclusive. Suton et al. (16) reported significantly higher GH response to acute exercise in non-trained compared with trained subjects while Manetta et al. (11) found three times greater GH response in trained subjects. The results of numerous studies showed no significant differences in GH response to acute exercise with respect to the differences in the level of physical activities (6,17,18). Our results demonstrated successive increase in serum GH concentration during acute dynamic exercise with the peak observed at the end of exercise in both athletes and in controls. The marked increase in serum GH concentration compared to basal values was observed in 24^{th} minute of exercise in both groups. Bunt et al. (2) found faster GH response at the beginning of exercise in subjects with lower level of physical activity and it was explained by possible higher sympathetic sensitivity. That was supported by the results of Guistino et al. (5) and Mazzeo et al. (19) that showed that sympathyc activation is very important mediator of GH response to acute exercise. Serum GH concentration decreased in the recovery period compared to the concentration at the end of exercise and the reversion to basal values was faster in athletes. Mc Ardle et al. (13) also observed the maintenance of high serum GH concentrations in non-trained subjects for even more hours after acute exercise. Chronic physical exercise (training) causes morphological adaptive changes which result in the changes in proportional participation of particular components in total body mass. The relationship between these components and serum GH concentrations during acute exercise are very complex. Numerous studies stress the impact of fat body mass to GH secretion. It was observed that subjects with diminished GH secretion are frequently obese (4) or that obesity is accompanied with diminished GH secretion (20). GH possesses verified lipolytic activity (21) and if applied subcutaneously causes an acute increase in free fat acids (FFA) in serum (22), which cause inhibition of GH secretion (23). Body composition and age are the main factors that affect the magnitude of GH secretion (24). Although there were significant differences in body composition between athletes and controls in our study, significant correlation between fat, non fat, and bone component of body mass and serum GH concentrations was not found either in rest, during exercise or recovery period in any group. Previously reported results that indicate a correlation of percentage of fat body mass and the GH response to acute exercise were based on studies that included obese subject with excess fat body mass. Kanaley et al. (9) showed that GH response (total GH secretion) to acute exercise of moderate intensity is significantly higher in standard body mass subjects compared to obese subject. As possible reasons for this they consider the increase in concentration of insulin (GH antagonist), IGF1 and FFA in serum. Our results showed that higher level of physical activity influenced the body composition decreasing fat and increasing non-fat, muscle component. We did not confirm that those changes influenced the dynamics of changes in serum GH concentration in response to acute exercise. It could be explained by the fact that in spite of the observed significant differences in percentage of fat body mass between athletes and controls, the percentage of fat body mass in both groups of subjects was within the range of standard values for this age group (1). It is possible that body composition, fat component of body mass in particular, could influence the GH response to acute exercise only in subjects with some level of obesity.

Conclusion

Growth hormone does not only play several very important roles in metabolism of fat, carbohydrates and proteins, it could also be used in persons with deficit of this hormone as well as doping in sports. Because of its relations with body composition and the problems of the overweight and obesity in many countries all over the world it could be interesting to continue the study on this relation.

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