



Analysis of Hormonal Responses to Aerobic and Anaerobic Zone Training

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ABSTRACT

The purpose of the present study was to examine and compare hGH, cortisol, plasma testosterone, epinephrine and nor epinephrine levels following an Aerobic and Anaerobic zone training. 39 male football players of age (18.08±1.09), height (172.15±4.76) and weight (61.52±7.06) were randomly distributed into three groups, aerobic zone group (n=13), anaerobic zone group (n=13) and control group (n=13). The subjects reported to the laboratory between 8-9 a.m. after an overnight fast. They were instructed to avoid caffeine and alcohol consumption for 24h and not to perform any physical activity for 48h before the experimental sessions. After reporting to lab the subjects were asked to take 20 minutes rest and the resting heart rate was observed with the help of heart rate monitor (S410) tied on the chest. With the help of HRmax(220-age) and resting heart rate the training zone was calculated by using Karvonen method. In aerobic zone group the subjects performed treadmill running at 75% of HRmax and in anaerobic zone group at 85% of HRmax till exhaustion. Blood samples were obtained before and immediately after the end of exercise from the antecubital vein. All the subjects performed exercise at the same time of day to avoid diurnal variation. In the control session, the subjects did not perform any exercise but they were sitting quietly for 45 minutes while blood samples were drawn at same time points. Data analysis amongst various groups was compared by one way ANOVA. Significant differences between means were located with the Tuckey HSD procedures. Aerobic and anaerobic zone training seems to be sufficient stimulus for an acute increase in hGH, cortisol, plasma testosterone, epinephrine and nor epinephrine concentrations where hGH and cortisol showed greater responses to high intensity exercise and plasma testosterone and epinephrine to long duration and moderate intensity exercise. These hormonal responses may create an optimal environment for the metabolic processes and improved cardiovascular functions.

Key words: cortisol, plasma testosterone, epinephrine, nor epinephrine

Introduction

Exercise is a stressor that stimulates both neuroendocrine and immune responses. Much of the influence on the immune system depends on the hypothalamic-pituitary-adrenal axis, which results in the release of cortisol from the adrenal cortex, and the sympathetic-adrenal medulla axis, which results in the release of the catecholamines from the adrenal medulla. Sympathetic nerve stimulation also directly innervates lymphoid organs. Exercise also causes the release of cytokines from skeletal muscle and immune cells, which help regulate the immune response⁽¹⁵⁾. The primary role of the endocrine system during an acute bout of exercise is to regulate the metabolic and cardiovascular systems (Bunt, 1986). Aerobic exercise stimulates GH release within approximately 15 min and induces peak values at or near the end of exertion⁽¹⁶⁾. The intensity and duration of aerobic stress, physical fitness, gender and age all influence the growth hormone response to exercise. In training adaptations and hormonal responses, concentric muscle actions produced a greater amount of growth hormone when compared to an eccentric muscle action⁽²⁾. In case of growth hormone the effect of exercise is largely independent of circadian rhythmicity, since the time of the day does not influence the responses at least in young men⁽⁵⁾. Exercising at 50% Vo₂max for 20 min does not cause an increase in cortisol levels, while at 70% Vo₂max, ACTH and cortisol increase⁽⁹⁾. During a high (100% of subject's maximum) and moderate (70% of subject's maximum) intensity strength workout, plasma cortisol increased more during the high intensity protocol⁽¹²⁾. Acute Short duration exercise to 60% Vo₂max results in ACTH and

cortisol release proportional to the intensity of the exercise⁽⁴⁾. Hormonal responses to resistance exercise in young males vary according to the exercise protocol employed (ie, maximum strength, muscular hypertrophy and strength endurance protocols). In general growth hormone and cortisol concentrations are higher following a hypertrophy protocol compared to a strength protocol, while a strength endurance protocol can cause even higher hormonal responses depending on the number of sets performed at each exercise⁽²²⁾

Levels of norepinephrine and epinephrine in arterial blood increase with exercise intensity, expressed by the percentage of maximal individual performance (% Vo₂max), and, as clearance of these hormones only changes moderately with exercise, changes in plasma levels can be attributed to changes in secretion and release⁽³⁾.

Trained men (sprint) showed a higher epinephrine response to short-term exercise compared with that of untrained counterparts. With resistance exercise there is an immediate increase in epinephrine and nor epinephrine^(6,7). These hormones increase blood glucose and are important for increasing force production, muscle contraction rate, and energy production (i.e., the synthesis of ATP-the energy currency of cells). These hormones actually begin to rise prior to the resistance training workout^(6,7).

Protocols high in volume, moderate to high in intensity, using short rest intervals and stressing a large muscle mass, tend to produce the greatest acute hormonal elevations (e.g. testosterone, GH and the catabolic hormone cortisol) compared with low-volume, high-intensity protocols using long rest intervals⁽⁷⁾.

Glucocorticoids are released from the adrenal cortex in response to the stress of exercise. Of these, cortisol accounts for approximately 95% of all glucocorticoid activity. Cortisol has catabolic functions that have greater effects in type II muscle fibres. Catecholamines reflect the acute demands of the resistance exercise protocol and are important for increasing force production, muscle contraction rate, energy availability, as well as several other functions including the augmentations of hormones such as testosterone⁽⁷⁾

Moderate aerobic exercise appears to enhance immune function, and the cells of the immune system return to resting levels soon after exercise. Severe, exhaustive aerobic exercise, in contrast, causes an enhanced immune function followed by a suppression of cell activity. These different responses appear to depend largely on the hormones epinephrine and cortisol. During exercise at greater than 60% of VO₂max, epinephrine and cortisol levels in the blood begin to increase rapidly, reaching their highest level after maximal exercise. Epinephrine is associated with a substantial increase in the number of lymphocytes in the blood. Cortisol causes an increased number of neutrophils but a decreased number of lymphocytes⁽¹⁵⁾

Previous researches have focused on protocols of high volume, moderate to high intensity, rest intervals and to our knowledge there is less evidence available which shows hormonal responses to different heart rate training zones. As heart rate monitor is a commonly used training tool and the present study will reveal the changes in hormonal levels with respect to varying percentage of HRmax. The purpose of the present study was to examine and compare hGH, cortisol, plasma

testosterone, epinephrine and nor epinephrine levels following an Aerobic and Anaerobic zone training.

Materials and Methods

39 male football players of age(18.08±1.09), height (172.15±4.76) and weight (61.52±7.06) were randomly distributed into three groups, aerobic zone group (n=13), anaerobic zone group (n=13) and control group (n=13). Before the initiation of study, a written informed consent was obtained from subjects and the experimental protocol was approved by the Institutional ethics committee.

Experimental procedure

The subjects reported to the laboratory between 8-9a.m. after an overnight fast. They were instructed to avoid caffeine and alcohol consumption for 24h and not to perform any physical activity for 48h before the experimental sessions. After reporting to lab the subjects were asked to take 20 minutes rest and the resting heart rate was observed with the help of heart rate monitor(S410) tied on the chest. With the help of HRmax (220-age) and resting heart rate the training zone was calculated by using Karvonen method. In aerobic zone group the subjects performed treadmill running at 75% of HRmax and in anaerobic zone group at 85% of HRmax till exhaustion. Blood samples were obtained before and immediately after the end of exercise from the antecubital vein. All the subjects performed exercise at the same time of day to avoid diurnal variation. In the control session, the subjects did not perform any exercise but they were sitting quietly for 45 minutes while blood samples were drawn at same time points

Blood Analyses

Five ml of blood was drawn at each sampling time. Two ml blood was transferred to simple tube and three ml to EDTA tube and centrifuged at 2500rpm for 15 min. Plasma and serum were separated and stored at -2 to -8 degree Celsius. Testing of cortisol and hGH was done in serum and of plasma testosterone, epinephrine and nor epinephrine was done in plasma with APR-4 Microplate reader.

Statistical Analysis

Descriptive data are presented as means and standard deviations. Data analysis amongst various groups was compared by one way ANOVA. Significant differences between means were located with the Tuckey HSD procedures.

Results

Human growth hormone-Serum hGH concentrations showed significant rise in aerobic (75% of HRmax) and anaerobic zone (85% of HRmax) group where as controls did not show any change. Tuckey HSD showed that this rise is significantly higher in anaerobic zone group ($p < 0.001$)

Table-1. Comparison of pre and post training, mean values of human growth hormone in anaerobic zone, aerobic zone and control group

Group	Anaerobic group		Aerobic Group		Control Group	
	Pre	Post	Pre	Post	Pre	Post
Mean	5.95	19.89	2.61	6.16	2.94	3.06
SD	0.65	2.74	0.34	0.87	0.46	0.44
P	<0.001		<0.01		NS	

The table -1 depicts that there is significant change in aerobic and anaerobic zone group where as control group did not show significant change in the levels of growth hormone.

Table-2. Comparison of pre and post training, mean values of cortisol in anaerobic zone, aerobic zone and control group

Group	Anaerobic group		Aerobic Group		Control Group	
	Pre	Post	Pre	Post	Pre	Post
Mean	70.07	112.27	53.12	91.13	59.99	59.07
SD	5.16	10.36	5.02	12.41	4.54	4.48
p	<0.01		<0.01		NS	

The table -2 depicts that there is significant change in aerobic and anaerobic zone group where as control group did not show significant change in the levels of cortisol.

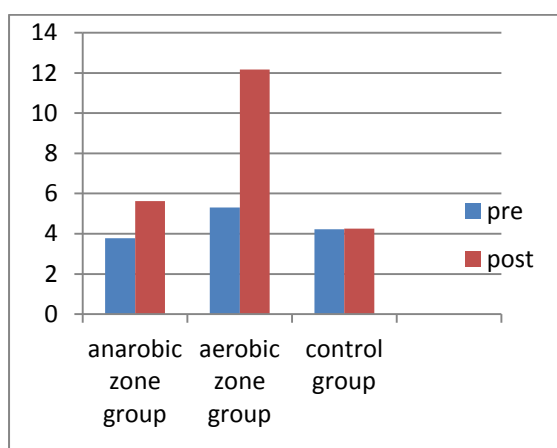
Cortisol –cortisol showed significant rise in aerobic and anaerobic zone group but there was no significant difference in post values of both the groups(p=0.38) where as controls did not show any significant change.

Plasma testosterone-Both the groups showed significant rise but it was significantly higher in aerobic zone group (p=0.001) where as controls did not show any significant change.

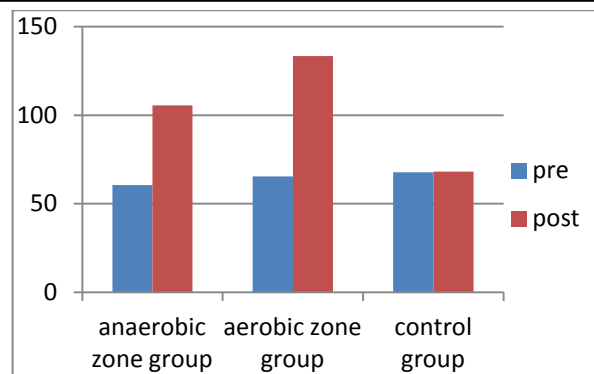
Epinephrine – Epinephrine showed significant rise in both the groups but it was significantly higher in aerobic zone group (p=0.001)

Nor epinephrine-Nor epinephrine also showed significant increase in both the groups but there was no significant difference in post values of both the groups where as controls did not show any significant change.

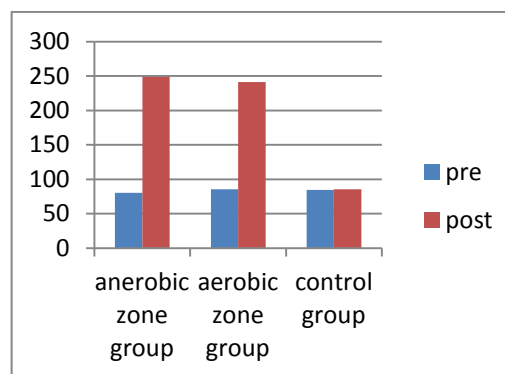
Comparison of pre and post training mean values of plasma testosterone (nmol/L) in anaerobic zone, aerobic zone and control group.



Comparison of pre and post training mean values of epinephrine (pG/ml) in anaerobic zone, aerobic zone and control group



Comparison of pre and post training mean values of nor epinephrine (pG/ml) in anaerobic zone, aerobic zone and control group



Discussion

In the present study a significant increase was observed in hGH in aerobic (75% of HRmax) and anaerobic zone (85% of HRmax) group but it was significantly higher in anaerobic zone group. Previous studies also showed that intensity and duration of aerobic stress influence the growth hormone response to exercise⁽²⁾. Furthermore aerobic exercise stimulates GH release within approximately 15 min and induces peak values at or near the end of exertion⁽¹⁶⁾

Cortisol showed significant rise in both the groups but was more in anaerobic zone group where the athlete was running at 85% of HRmax and the previous researches have also explained that during a high(100% of subject’s maximum) and moderate

(70% of subject's maximum) intensity strength workout, plasma cortisol increased more during the high intensity protocol⁽¹²⁾

Plasma testosterone showed significant increase in both the groups and it is supported by the previous studies where protocols high in volume, moderate to high intensity, using short rest intervals and stressing a large muscle mass, tend to produce the greatest acute hormonal elevations in testosterone, growth hormone and cortisol⁽⁷⁾

In the present study epinephrine showed more increase in aerobic group as compared to anaerobic group which can be attributed to the fact that in anaerobic exercise the plasma epinephrine concentration increases very rapidly at the beginning but when exercise targets a specific load epinephrine increases less rapidly⁽¹⁰⁾. The increase in the concentration of nor epinephrine was more in anaerobic group (85% of HRmax) in the present study. These findings are supported by a previous study which showed that highest concentration of nor epinephrine appear when heart rate is already close to its maximum value⁽¹¹⁾

Conclusion

Aerobic and anaerobic zone training seems to be sufficient stimulus for an acute increase in hGH, cortisol, plasma testosterone, epinephrine and nor epinephrine concentrations where hGH and cortisol showed greater responses to high intensity exercise and plasma testosterone and epinephrine to long duration and moderate intensity exercise. These hormonal responses may create an optimal environment for the metabolic processes and improved cardiovascular functions.

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