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The Effect of maximal progressive exercise on serum cortisol & immunoglobulin a responses in young elite athletes

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ABSTRACT

The purpose of this research was to evaluate the serum cortisol and immunoglobulin-A (IgA) responses to maximal progressive exercise in elite male and female athletes. Twenty-four elite athletes who had experience in national team or played on league championship voluntarily participated in this study (ages: 22.46 ± 3.37 yr, height: 175.54 ± 8.68 cm, weight: 70.02 ± 13.60 kg, body fat percent: 15.86 ± 5.78 and maximal oxygen uptake: 55.14 ± 7.39 ml/kg/min). Subjects that included eleven male and thirteen female performed progressive exercise test on treadmill. Blood samples were taken for analysis of cortisol and IgA concentration. The results showed that serum cortisol concentration significantly increased in both male and female elite athletes after incremental exercise. However, there was not any significant changes in serum IgA levels in both groups following incremental exercise. Based on our results, it could be concluded that maximal progressive exercise increased serum cortisol concentration but it didn't affect on serum IgA concentration.

Key words: serum cortisol, immunoglobulin A, progressive exercise, elite athletes.

INTRODUCTION

In our living environment there are numerous threatening infectious agents, but human's body is equipped with the defense mechanism. Intensive physical activities, particularly, due to exercise can influence immune defense system. Hence, if the volume and intensity of training is beyond the physiological capacity of athletes, leads to numerous physiologic disorders. In this relation, we can point out to the hormonal and immunologic disorders. These changes results in unwanted consequences hence should be controlled. Cortisol is the main catabolic hormone. It is a steroid

hormone, secreted from the cortex layer of adrenal gland, and mainly has catabolic effects. Cortisol response to stress always has been under attention as an indicator in expressing the work pressure. Various data about the relation between cortisol and work have been obtained. This stress could be under the mental stimuli, like daily work tenses [27] or physical exercises [8,22]. It leads to performance decline during training or competition. Though, the highest long term cortisol response to the stressor has been observed 24 hours after the effect of the stressor [15]. Since one of the effects of the cortisol is its suppression on the immune system, during and after physical exercises the serum, plasma and salivary cortisol level increase. Due to this reason, IgA level reduction has been attributed to the increase of cortisol level. Because serum level cortisol affects on the B lymphocytes and prevents antibody production [29] and reduces Immunoglobulin production [20]. Jacks et al (2002), on their study on the effect of training at 3 different intensities on the salivary cortisol concluded that the low and moderate intensity training can not change the cortisol concentration, but high intensity training significantly increased cortisol [13]. On the other hand, the immune system is one of the main body systems, plays protective role against the pathogenic organism, because body is always exposed to different microorganisms. Without immune defense system and even in case of its attenuation individuals face problems [12]. IgA is one of the main secretory substances. The main secretions in which IgA could be identified are as follow: tear, milk (specially, colostrum), nasal secretion, respiratory system mucous secretion, digestive tract mucous secretion (saliva and bile) and the genito urinary tract secretions [25]. IgA is the main antibody in the external secretion and has main biological function in these areas. This Ab plays very important role at the first line of immunologic defense against the localized infections such as in respiratory system.

In addition to the protective role of IgA against the local infections, this immunoglobulin has the anti-bactericidal property against the gram negative organisms, but this function takes place in presence of lysozyme, and lysozyme is present in the secretions containing the secretory IgA [16]. Some studies reported that the rate of upper respiratory infection following intense training and competition increases. Gleeson et al (2002), beliefs that cortisol concentration changes following athletic activities are depended to the intensity and the duration of the exercises(11).

Ring et al (2005), investigated the effect of competition and the mental stress on the immune system in 62 young active men. The study subjects were allocated in one of the 4-state- 8-minute exercise: the mental calculation, bicycling with the work load of 60-120 watt, competitive bicycling, and mental calculation with bicycling. Results showed that, mental calculation as compared with the resting condition led to a significant increase of the concentration and rate of IgA secretion. The competitive exercise and the exercise, itself, had no effect on the rate of IgA secretion [24]. Hypotheses have shown that mental stresses of participating in the competitive match make the athletes more susceptible to infection by reducing the IgA concentration [24].

Demitriou et al (2000), after investigating the IgA and cortisol in the elite swimmers found that, training has no significant effect on salivary IgA concentration, but significant difference was observed in cortisol concentration before and after training (5). While the other studies indicated that the concentration and amount of IgA secretion due to exercise declines [28] or remain unchanged [19,22].

Hence, considering the presence of contraindicating data, we decided to investigate the effect of one session progressive exercise on the serum IgA and cortisol in the elite male and female athletes, and present the proper strategy to improve sport of Iran in international competition events to the athletic society of world, and by performing them provide situation for archiving of more success in the international sport events.

MATERIALS AND METHODS

Participants

Twenty-four elite athletes male (N=11) and female (N=13) that play experience in national team or have trade of champion surnames in league volunteered to participate in this study. After giving oral and written information about the study's plans and procedures, subjects signed an informed consent. The interview and examination by physicians showed that subjects were in good state of health. All subjects were non-smokers, were not under medical treatment and history of hormonal disorder at the time of the study. The general features of the subjects are given in the table-1.

Table 1. General features of the study subjects bases on the reported mean and standard deviation

Features	Athletes N=24	Male athletes N=11	Female athletes N=13
Age (years)	22.46±3.375	21.45±4.156	23.31±2.394
Weight (Kg)	70.02±13.606	81.81±9.978	60.05±6.05
Height (Cm)	175.54±8.683	182.36±7.173	169.77±4.781
Body fat (%)	15.86±5.78	13.93±4.687	17.79±6.879
Maximal oxygen uptake (ml/Kg/min)	55.14±7.396	57.16±9.798	53.12±4.994

Procedures

Five days before the first exercise test, each subjects was familiarized with the procedures for running on the treadmill (Techno Gem, HC 1200, ITALY). For the first test, each of the subjects performed maximal progressive exercise on treadmill to measure cortisol and IgA responses. The procedure of maximal progressive activity was as follows: the subjects ran on treadmill for warming up, at step of zero angles and with the speed of 4 miles/ hour. After 3 min. one mile/hour was increased to the speed. Then, each two minutes, one bout without resting time, 1mile/hour was increased on speed. Running continued till the subjects could not continue and expressed their exhaustion. Maximal oxygen consumption (VO_2max), was estimated from the 1600-meter protocol running on electronic treadmill [9]. Caliper was used to measure the subcutaneous fat from 7 areas of the body was measured using Jackson and Polack formula [14].

Serum sampling

For measurement of serum cortisol and IgA, before exercise, subjects sat down and rested for 25 minutes before a blood sample was collected. The blood samples were collected 20 minutes before activity (pre exercise) and immediately after physical exercise (post exercise) in both male and female groups. Both samples were put on ice and sent immediately to the laboratory for freezing at -20 degrees and centigrade for subsequent testing. In addition, to prevent any environmental influences apart from time of day, samples were taken from all subjects in similar conditions.

Hormonal analysis

Blood samples (5 ml) were drawn from an antecubital vein into 10-ml serum Vacutainer tubes and after approximately 45 min, serum tubes were centrifuged at 3000 rpm (5000 g) for 10 min at room temperature. Serum was separated from blood cells and stored at -20 °C until analyzed. Serum cortisol concentrations were determined using enzyme immunoassay (RADIM SpA-Via del Mare, 125-00040 Pomezia (Roma) Italia). And serum IgA concentrations were determined

by nephelometric method using MININEPHTM HUMAN IgA kit (The Binding Site Ltd., Birmingham, UK) To eliminate interassay variance, all samples for a particular assay thawed once and analyzed in the same assay run. All samples were run in duplicate with a mean inter- and intra-assay coefficients of variances were 6.9% and 6.2% for serum cortisol and intra-batch and inter-batch precision were 2.60 % and 3.62 % for IgA. All samples from each subject were analyzed on the same day.

Statistical analysis

The result were expressed as the mean ± SD. Data for the pre- and post-exercise trials were compared using a two-tailed, paired *t*-test in each group. *Independent t*-test was used to compare the statistical differences in male and female groups. All of the statistical analyses were done using the SPSS 16 software. Differences among means were considered statistically significant by the criterion of probability value =0.05.

RESULTS

An acute bout of maximal progressive exercise significantly increased serum cortisol concentration in both male and female elite athletes groups ($P < 0.05$) (Fig 1). Comparison of cortisol concentrations in the male and female post-exercise indicated that level of this hormone was not significant differences. (Fig 1). Comparison between resting state of serum cortisol indicated that in both male and female subjects was not observed significant difference as well ($P > 0.05$).

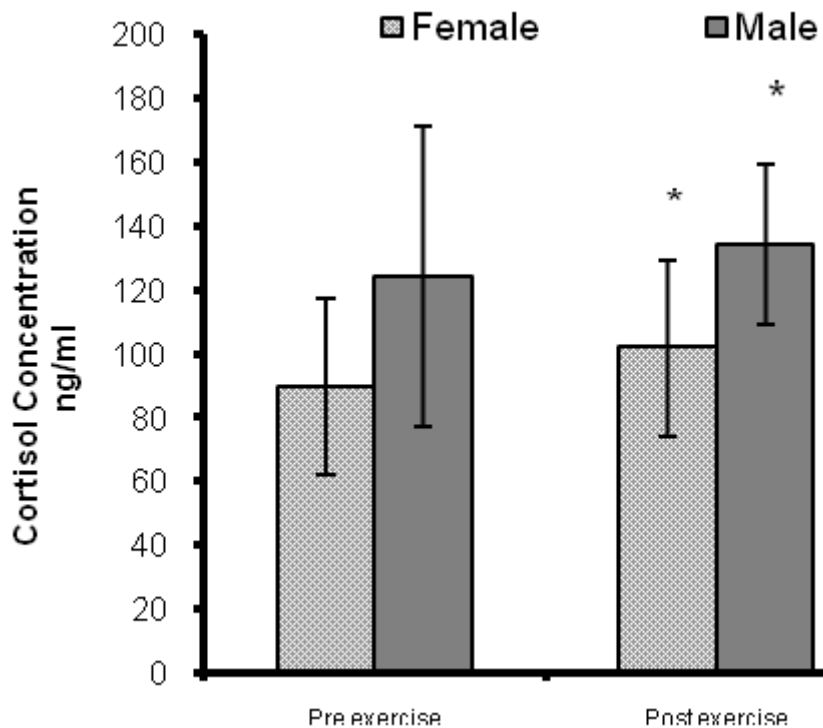


Figure 1. Serum cortisol concentration (mean ± SD) during pre and post-maximal progressive exercise to the exhaustion in the male and female.

* Significant difference with pre-exercise

However, serum IgA levels there was not any significant differences in both male and female elite athletes groups. Hence, IgA levels was not under the influence of maximal progressive exercise neither in both male and female elite athletes groups ($P>0.05$). little difference was observed between pre and post exercise in both male and female subjects that was not significant (Fig 2).

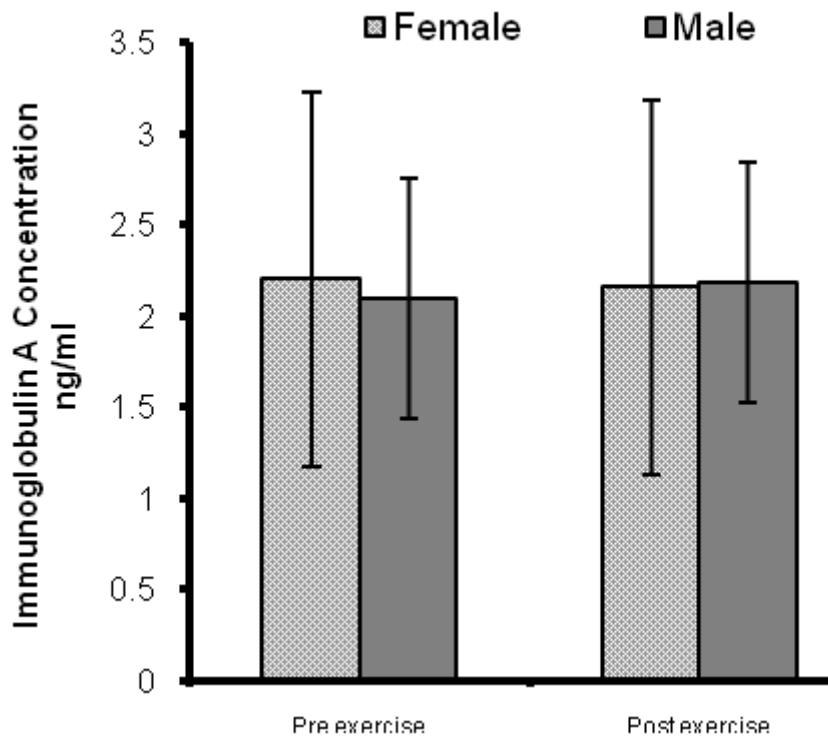


Figure 2. Serum immunoglobulin A concentration (mean ± SD) during pre and post-maximal progressive exercise to the exhaustion in the male and female.

DISCUSSION

Based on the first finding of the present study, a significant increase of serum cortisol concentration was observed after one session progressive exercise. In contrast to the report given by [21,23]. corresponding the data given by [5,8,13]. It has been suggested that cortisol measuring being one of the main hormonal indices for determination of physiologic pressure of exercise. Numerous studies have indicated that change in the cortisol concentration is related to the intensity, duration, type, environment of exercise, the level of readiness and mental pressure of the subjects [18]. The intensity plays more important role as compared with the other factors such as duration [30].

There are different mechanisms showing the reason of cortisol concentration increment following exercises. The first suggested mechanism is the increase of hormone secretion from the adrenal gland; the role of metabolic cleaning rate by the liver at the time of exercise has no important role in increase of hormone concentration; and the rate of hormone secretion is more important than the rate of hormone metabolizing [17]. Stimulation of Hypothalamic-pituitary-adrencortical (HPA) axis and increase of ACTH secretion from hypophysis is considered the main factor of cortisol secretion stimulation [2,17].

As the result, the main neuro-psychological system influenced by stress, is the hypothalamus-pituitary adrenocortisol (HPA) axis [2]. In a way that during physical activity the HPA axis being activated and hormone secretion increases [3]. The anaerobic metabolism product like, lactate accumulation, pH drop and hypoxia are the HPA axis stimuli. The previous studies have shown that running on treadmill, within 8 to 20 minute increases the ACTH concentration up to 10 fold. In this condition the cortisol secretion increases with increase of ACTH [3]. In the present study, the subjects ran on treadmill in average 11 min. Though the ACTH concentration was not measured, but considering the data obtained from the previous studies this period of exercise could lead to the significant increase of ACTH concentration. It is possible to attribute the cortisol concentration increase to the ACTH increase. Increase of the central temperature, and pH decline are the other mechanisms causing increase of cortisol level, particularly of free cortisol [3].

Filaire et al (1998), in their study on the comparison of cortisol concentration in the swimmers and handbalists found the increase of cortisol level in the handball players, but insignificant in the swimmers. Since the subjects were male handbalist, this data corresponds our finding [8]. In the present study, the cortisol response after one session progressive exercise revealed significant increase which seems the subjects in this study faced high body strain. What is apparent to us is that, the quality of stressor, plus duration and intensity of exercise intensity affect on the response to cortisol secretion.

Therefore it could be stated that, physical exercise is one of the main cortisol secretion stimulate [13]. Considering the above mentioned items, it could be stated that the reasons of difference with the other studies are the type of athletic game, training environment, the intensity and duration of exercise, the level of athlete readiness, age, gender, nutrition status and the mental pressure. Other findings of the study revealed that the serum IgA concentration after one session progressive activities did not change in the male and female subjects. The present data agrees with the report given by [5,24]. but disagrees with the data given by [6,11,28]. The highest amount and most frequent IgA secreted locally and has short half life which binds to bacterial antigens selectively. Thereby, prevents the invasion of bacteria to the mucous membrane [1]. Researchers have suggested different mechanisms in explaining changes in IgA concentration are as follow: the rate of immune system suppressive hormone secretion such as, cortisol, epinephrine, encephalinen, sympathetic nervous system activity, the mental and physical stress and decline of salivary flow [10]. Gleeson et al (2002), believe that intensive training causes attenuation of IgA, on the other words, attenuation of immune system [11].

While in the present study severe exercise had significant effect on the IgA level. Rimmel and Zellwoger (2007), stated that changes in the immune system, and susceptibility to infection on the athletic events has psychologic bases rather physiological [24]. Farzanaki et al (2008), on their study on the salivary IgA and cortisol responses to the changes of intensive training in the elite girl gymnasts, found that intensive exercise cause insignificant of IgA, which somewhat agrees our results, but disagree about the cortisol concentration after intensive exercise [7]. Considering the above mentioned point, it is possible to state that the reasons of difference between our data and the other studies could be related the difference between the intensity and duration of exercise and the level of the subjects readiness. Therefore, designing training programs, conducting the tournament, and arranging competition program should be done in a way that impose less complication in cortisol secretion and the problem on the immune system of the athletes.

CONCLUSION

In summary the result of the present study, showed that, acute bout of maximal progressive exercises on treadmill in elite athletes were causes significant changes on the serum cortisol concentration in both male and female groups, However, acute bout of maximal progressive exercises did not suppress IgA secretion, which is a part of immune system components, in elite athletes. The greater cortisol concentrations in maximal progressive exercise program in this study confirm that acute bout of heavy exercises produces significant physiological hormonal responses in elite athletes, but dose not decline serum IgA concentrations, which has important role in immunity.

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