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## The Effects of a Session of Aerobic and Anaerobic Exercise on Leukocytes, And Hormonal Responses in Young Women

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### ABSTRACT

**Background.** Exercises with different intensities can cause changes in immune system factors and hormonal acute response. These changes may exceed the permissible limitations and weaken the system.

**Objectives.** The purpose of this study was to compare the effect of an intensity aerobic and anaerobic training session on acute hormonal response and immune system factors.

**Methods.** A total of 30 young female non-athlete students (age  $20/7 \pm 1$  years old and BMI  $23/2 \pm 1/3$ ) participated in the study voluntarily. And randomly were divided into three groups: maximum aerobic, anaerobic test and control group ( $n = 10$ ). from subjects before and after the test, blood samples were taken to measure cortisol, testosterone and leukocytes. For maximum aerobic test, Ellestad test was used, and for anaerobic, Cunningham and Faulkner treadmill test was used.

**Results.** It is showed that the leukocytes in anaerobic test significantly increased ( $p < 0.05$ ). On the other hand, anaerobic exercise leads to a significant increase in testosterone level ( $p < 0.05$ ) and a significant reduction of cortisol levels ( $p < 0.05$ ).

**Conclusion.** In general, these findings show that despite minor differences in the effects of physical activity on the hormonal responses and immune system, Increase of anabolic conditions after anaerobic activity may be increase of leukocytes.

**KEY WORDS:** *Leukocytes, Testosterone, Cortisol, Aerobic Exercise, Anaerobic Exercise.*

### INTRODUCTION

Physical activity has different effects on different body systems (1, 2). In most cases to exercise, positive and constructive role in the performance of the system can be considered (3, 4). But this is different about the immune system (1, 2, and 5). At first it was thought that exercise and sports impact on the human immune increase, and this effect by increasing the intensity and duration of exercise would increase (6, 7) Gradually, and with further research it was

found that this relationship is not linear and direct in communication, and is much more complex than initial ideas (8, 9). Studies also have shown that immediately after exercise increased, leukocytosis will occur (acute level of leukocytosis) (10). Increase in leukocytes particularly neutrophils and monocytes, were applied extensive actions in the cycle of damage and in repair of the muscle. Recent findings show that neutrophils can directly to destruct the

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muscle cell membrane through Respiratory burst, a mechanism dependent by super oxidase (11). Inflammation is also the result of the movement of cells and fluid from the blood vessels into the extracellular space, which can contribute to pain and inflammation (12, 13). As a result, reactive oxygen species may be produced by certain cells of the immune system that these species, such as neutrophils and monocytes produced and may leads to cell damage, and are also involved in the aging process (14). However, Exhaustive aerobic training that caused damage of muscle cell and release of muscle injury markers, such as creatine kinase and lactate dehydrogenase Into blood flow (15, 16). In this regard BaniTalebi *et al.* (2013) examined changes in fibrinogen and some indicators of stress hormones and the immune response to the Soccer competition judges, the results of this study showed that significant increase of fibrinogen, cortisol and lymphocyte after soccer matches than the rest. While the difference in the amount of testosterone, Testosterone to cortisol ratio, leukocytes and neutrophils and monocytes Were not changed (1). One the other hand many people believe that the high intensity training will increase resistance of the immune system (9, 16), on the other hand, while testosterone and cortisol Plays a key role in metabolic processes such as glucose metabolism, protein and fat, immune system and other related processes to have a lot of homeostasis, which can also affect on performance. Cortisol has a responsible facilitating role in some of the vital processes. cortisol Plays a key role in physical activity and exercise, such as anti-inflammatory and protein breakdown (17). Studies have examined the effect of aerobic exercise on cortisol and testosterone levels different results reported. In this regard Attarzadeh Hosseini SR *et al.* (2012) reported that in a Soccer session in elite Soccer players had increased testosterone and Cortisol (18). Lancaster *et al.* (2004) reported that exhaustion aerobic training had no significant influence on the cortisol concentrations (19). While Handziski *et al* (2006) found significantly increased testosterone concentration with Soccer match, that increase in cortisol was not statistically significant (20). However, other studies also have shown that long-term and High intensity exercise on the immune system, Leads

upper respiratory tract infection and destruction of the Immune factors (21, 22). Therefore, more evidence is needed to explain the nature and clinical feature of this immune and hormonal responses .on the other hand Different kinds of exercise may have various effects on immune parameters based on the nature, intensity and time delay between exercise bouts and immune parameter (9, 16, 21, and 22). Considering the possible role of hormonal changes and immune system as the interface between physical activity and health, and according to inconsistency and limited results of previous studies, present study was to evaluate the effect of aerobic and anaerobic exercise intervention and comparing these interventions on the immune system and hormonal responses in young women.

## MATERIALS AND METHODS

**Participants.** The participants of this study are Non-athletic female students in Islamic Azad University of Gorgan. To determine the participants, after the notification and invite students living in the dormitories of the University by invitation, the volunteers were enrolled. To determine the participants, after the notification and invite students living in the dormitories of the University by invitation, the volunteers were enrolled. All participants were healthy regarding their hearts, respiratory systems, kidney, metabolic function or having no orthopedic injuries that harnesses their physical activities and their health was verified by a doctor. All participants received written information about the study including an explanation of the risks of doing the Thirty healthy females (mean age  $20.7 \pm 1.1$ , average BMI  $23.2 \pm 1.3$ ) participated in this study (Table 1). The participants signed the informed consent. The participants had not involved in any physical training program for at least two years. Subjects divided randomly in each of the three groups (aerobic, anaerobic and control) groups (n = 10).

**Study Design.** A meeting was held to familiarize subjects with exercise activities and the blood sampling technique. To reduce some confounding factors affecting results of the study and to reduce the effects of food type on hormonal responses and immune indices, subjects were asked at the meeting for at least 24

hours before the training program and blood sampling to ensure abstinence from fast food consumption and caffeine drinks. Blood samples were taken from subjects in 2 steps, 48 hours before training (stage 1) and 48 hours after the last training session (step 2). In each step, 5 cc of blood was collected. Exercise activities were only given to experimental groups and the control group received no exercise intervention.

**Training Protocol.** The exercise protocol in this study, including aerobic activity (Ellestad test) 7-step protocol, used to estimate maximal aerobic power ( $\text{vo}_{2\text{max}}$ ) for 16 minutes to run. If the participants are not able to continue the test, stops immediately and subjects' heart rate activity in the recovery period will be recorded for 15 seconds. The first 4 steps gradient of 10%, the rate of respectively 1.7, 3, 4 and 5 miles per hour (mph) runs respectively 3, 2, 2 and 3 minutes and 3 final step gradient of 15%, the rate in the order of 6, 7 and 8 mph and run 2 minutes in every 3 Step (23). Anaerobic activity (Cunningham and Faulkner treadmill test) is a maximal anaerobic test on the treadmill begins at a speed of 8 miles per hour (mph) and a 20% gradient, and will continue as long as the subject is exhausted and unable to continue (24).

**Measurements.** On the first day of the study, each participant was referred to the Exercise Physiology Laboratory to evaluate for height, weight and body mass index (BMI). Body Mass Index (BMI) was obtained by dividing weight (kg) by height (m). The blood pressure was taken using medical sphygmomanometer and resting heart rate after 5 minutes of rest on the seats were taken, and immediately blood samples (first stage) of the vein in right wrist after were collected after 5 minutes to warm up muscle tone coarse and 3 minutes' kenotic movement. Electrical transmitter Suunto to monitor heart rate was installed on the chest of subjects and subjects placed on a treadmill to test. The tests time were recorded by stopwatch. Immediately after the test, the subjects' heart rate was registered and 5 ml of blood was obtained from the anti-cubital vein of right hand of subjects (second stage). After each stage, blood samples were taken have been sent to medical laboratory to study leukocyte count by counting with automatic EXCELL22 and total testosterone levels, and were measured according to Nanograms per milliliter using SIEMENS kits made in Germany. Cortisol was carried out based on dl using SIEMENS kits made in Germany by utilizing Chemiluminescence method.

**Table 1.** The average and standard deviation of the individual characteristics of subjects in each group

Groups	BMI ( $\text{kg/m}^2$ )	Weight (kg)	Height (cm)	Age (years)
Aerobic Exercise	23 $\pm$ 1.49	50 $\pm$ 2.23	150.7 $\pm$ 4.16	20.15 $\pm$ 1.18
Anaerobic Exercise	23.20 $\pm$ 3.15	52.13 $\pm$ 3.39	154.6 $\pm$ 6.12	20 $\pm$ 0.79
Control	23.10 $\pm$ 2.13	53.1 $\pm$ 3.96	155.2 $\pm$ 4.17	21.26 $\pm$ 1.13

**Statistical Analysis.** To describe data obtained for each of the study variables, frequency, mean and standard deviation were used (Table 2). Smirnov test was used to determine data distribution. Data analyzed after determining normal subjects, t-tests and ANOVA for the observation of the difference between the experimental and control groups, follow up Tukey test was used to determine differences between groups. Statistical analysis was performed by software SPSS 14 at significant level  $P < 0.05$ .

## RESULTS

The results showed significant change in the amount of testosterone and cortisol in anaerobic training ( $p < 0.05$ ), compared to pre-test.

Anaerobic training group (Cunningham and Faulkner treadmill test) showed increase significant in leukocytes ( $p < 0.05$ ) and was more effective than pre-test. Anaerobic training increases testosterone more than the control group and was statistically significant ( $p < 0.006$ ) anaerobic training significantly decreased cortisol compared to controls ( $p < 0.030$ ) and significant increase in leukocytes ( $p < 0.020$ ) compared to the control group and there was no significant difference in pre-test and post-test in any of the variables studied after aerobic training and variables between the groups (aerobic training) have not statistically significant difference. Preliminary data obtained from

experimental and control subjects are summarized in Table (2, 3 and 4).

Table 2. Changes in blood parameters of the before and after aerobic training (Mean  $\pm$  SD).

	Leukocytes (mmol/Lit)	Cortisol (mic/dl)	Testosterone (ng/ml)
preTest	7.37 $\pm$ 1.21	13.77 $\pm$ 2.21	234 $\pm$ 0.34
postTest	7.38 $\pm$ 2.45	15.54 $\pm$ 2.02	2.3 $\pm$ 0.24
p (Intergroup)	0.43	0.5	0.27
p (Between group)	0.53	0.143	0.173

Inter-group t-test and ANOVA and post hoc Tukey  $p < 0.05$  difference was statistically significant

Table 3. Changes in blood parameters of the before and after anaerobic training (Mean  $\pm$  SD)

	Leukocytes (mmol/Lit)	Cortisol (mic/dl)	Testosterone (ng/ml)
pretest	7.48 $\pm$ 2.54	14.77 $\pm$ 2.51	2.34 $\pm$ 0.34
posttest	7.68 $\pm$ 3.05 $\dagger$ *	13.64 $\pm$ 1.12 $\dagger$ *	4.30 $\pm$ 1.29 $\dagger$ *
p (Intergroup)	0.05	0.05	0.05
p (Between group)	0.02	0.03	0.006

Inter-group t-test and ANOVA and post hoc Tukey  $p < 0.05$  difference was statistically significant

\* Significant differences between the three groups ( $p < 0.05$ ).

$\dagger$  significant difference with pre-test values ( $p < 0.025$ ).

Table 4. Changes in blood variables in the control group (Mean  $\pm$  SD)

	Leukocytes (mmol/Lit)	Cortisol (mic/dl)	Testosterone (ng/ml)
pretest	7.56 $\pm$ 1.51	13.6 $\pm$ 1.21	2.44 $\pm$ 0.44
postTest	7.53 $\pm$ 1.6	13.54 $\pm$ 1.52	2.4 $\pm$ 0.54
p (Intergroup)	0.53	0.51	0.87
p (Between group)	0.173	0.165	0.163

Inter-group t-test and ANOVA and post hoc Tukey  $p < 0.05$  difference was statistically significant

## DISCUSSION

The results showed that none of the factors studied did not show a significant change after aerobic exercise. The results of ANOVA showed no significant differences in aerobic group than the control group test. The findings are aligned with Schrhag *et al.* (2005) who were investigated the effect of 4 hours cycling at 70% of anaerobic threshold (25). In this regard Gavrieli *et al.* (2008) investigated the effects of Aerobic Exercise on neutrophil function in 23 male subjects for 30 minutes at 70% of maximal oxygen uptake in activity on the treadmill and showed no significant change in neutrophils(8). Contradicted by the findings Shek *et al.* (1995) conducted a study on 10 male endurance runner, found that the number of leukocytes was increased after endurance

exercise (26). It seems that this increase may be due to the pressures of adaptability endurance athletes and non-athletes in the present study, The results showed that significant increase in the leukocytes after anaerobic Cunningham and Faulkner treadmill test in this regard Pacque *et al.* (2007) reports that increase in the amount of leukocytes and neutrophils and decrease in lymphocytes after a ultra-endurance running race (9) in another study by Nielsen *et al.* (1996) also reports that an increase in leukocytes and its extracts. The study concluded that a 6-minute activity once the rowing ergometer leukocyte count increases as a reflection of increased levels of lymphocytes, monocytes and neutrophils. After two hours of rowing the number of neutrophils and leukocytes were maintained at

a high level, while the number of lymphocytes decreased below the initial value (27). Therefore the amount of lymphocytes decrease that In contrast with the present study, Perhaps this was due to blood sampling delayed time 2 hours after the workout. Also, it is shown that a time conflict may affect the hormonal system and consequently the immune system to create different effects. So, it can be imagining that a sampling time will have effect on the studied parameters. The Hack *et al.* (1997) studied the effects of 8 weeks of training on anaerobic leukocyte and lymphocyte function. The results showed high intensity training reduce the number of leukocytes (28), this inconsistency may be for several reasons. Including during training may be an adaptation of the body to stress of anaerobic exercise. As a result, compared to a session's examination of present study, creates compliance and no change in the number of immune cells is found. on the other hand, high intensity exercise exceeds the maximum allowed failure of new immune cells that produced some of the broken cells and does not represent a significant change, it creates a kind of immune suppression (2), on the other hand, the initial increase immune factors immediately after high intensity training may be due to rapid increase in levels of cortisol stress hormones and catecholamines (20,21). Therefore, this increase may be declined shortly after the completion of the exercise due to a drop in hormone levels again (29, 30), although the change in leukocytes is different. Changes in the leukocytes to physical and psychological stress were a two-stage response, which is associated with intensity of stress (31). The intensity and duration of training are two factors affecting the immune factor(2,7) In this regard, König *et al.*(2000) while reports that the effects of chronic with high intensity, found a significant increase in the prevalence tract infection upper respiratory, while Moderate intensity exercise is considered as a protector against infection (21). On the other hand, this study has shown that high intensity (anaerobic test ,Cunningham and Faulkner) increase the number of leukocytes, while Robson *et al.* (1999) reports three hours of exercise at 55% maximal oxygen uptake in the

immune system improvement, more than 38 minutes exercise at 80% of maximal oxygen uptake. In addition, 24 hours after a short-term of high intensity training (38 minute) leukocyte function return to levels before training, but neutrophil function in long-term training (3 hours) with low intensity in 24 hours after training, still significantly remained suppressed (32). Therefore long training sessions, may be suppress immune function in athletes. Findings of the present study show that there was not a significant change on leukocytes in Ellestad aerobic training. In this regard Tartibian *et al.* (2009) investigated the effect of two types of running on leukocytes and its extracts in untrained men, and reports that Moderate intensity exercise (60% VO<sub>2</sub> max) and intensity training (75 of VO<sub>2</sub> max) for 30 minutes, on the treadmill, increasing the number of leukocytes after exercise. But other factors of immune systems were not significantly different (7). On the other hand Results of the present study inconsistency with the results of the Shore *at el* (1999) (6). This inconsistency may be related to inadequate intensity and duration of the Ellestad and Cunningham and Faulkner or the Gender of participants. It seems that one of the main causes of changes in the immune system is stress hormones, which can be changed after stressful activity (29, 30). In this regard, Cumming DC *et al.* (1989) examined the effect of high intensity interval training on testosterone. Results showed that testosterone after 20 minutes was increased and then became constant (33). The mechanism that causes testosterone increase is yet unknown, but it is possible that testosterone increase in response to exercise, were include an increase in testicular blood circulation, activation of the sympathetic nervous system, increased plasma volume changes, increased secretion of testicular testosterone secretion in response to vasodilatation (34) respectively. Findings of the present study are consistent with those of other research (35, 36), shows that anaerobic training leads to increased levels of testosterone. On the other hand it seems that decrease cortisol levels after aerobic exercise group was proportional to the increase in testosterone in this group, which is probably

due to interaction of hormones (34). On the other hand, we can say that this type of exercise may increase blood lactate (anaerobic exercise) which is one of reasons for facing increasing testosterone. Although in the present study the concentration of lactate was not measured but several studies have support the relationship between testosterone increase in line with increased lactate (34, 35, 36). The high-intensity exercise program requires high energy costs. Intensity exercise due to increased glucose uptake by peripheral tissues in the presence of lactate, acidosis associated with increased sympathetic stimulation of the adrenal and energy costs, and changes to the immune system (37). In general, it can be concluded that, anaerobic exercise protocol in present study can be change in leukocyte and acute hormonal responses.

### CONCLUSION

Considering the relationship between the immune system and hormonal response, it could be said that anaerobic training increases testosterone and leukocytes and cortisol reduction. Therefore, we suggest that this group of people can use benefits of such practices using this method as acute to improve the immune system.

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### APPLICABLE REMARKS

- The results of current study indicated that anaerobic test (Cunningham and Faulkner) could be an appropriate method for increase in testosterone in young women.
- The anaerobic training could be a reliable effective method in decreasing Cortisol in young women.
- Ellestad test did not cause any change in leukocyte and acute hormonal responses.

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