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The Effect of Ambient Temperature and Exercise to the Level of Exhaustion on Heat Shock Protein and C-Reactive Protein Plasma Levels on Male Athletes

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Abstract

***Background*:** The increase in the amount of heat shock protein and C-reactive protein occurring as a result of stress was done with the aims of returning cell homeostasis, successful restoration of cell injury and protection of cell against more injuries.

***Materials and Methods*:** Fifteen climber and 15 non athlete subjects were chosen. A selected aerobic test was done by the subjects using Monark bicycle under two different conditions. Before starting the test, the subjects were exposed to a normal condition with the temperature of 24±2°C for an hour and a blood sample was taken from all the subjects. Then immediately, the subjects took the selected aerobic test to the level of exhaustion and blood sample was taken again. A week later, these subjects were exposed to a heated environment with the temperature of 38±2°C, followed by blood sample taking. Finally, the test was done by the subjects to the level of exhaustion and the last blood sample was taken. Then, the amount of heat shock protein (HSP) and C - reactive protein (CRP) in blood samples was measured.

***Results*:** A meaningful difference was observed in the changes of heat shock proteins (p=0.012) and C-reactive protein (p=0.02) between athlete and non athlete subjects. There was no meaningful difference in CRP and HSP in normal and hot condition for non athlete subjects before and after the test. But the result of the study demonstrates that There was a meaningful difference for athletes in both conditions before and after the test (p=0.002).

***Conclusion*:** Based on the study, it is claimed that while an athlete is exposed to several stressful conditions (e.g. high temperature and physical exercise), compared to a non athlete, the reaction of his body cells is more significant in order to prevent the injury.

Introduction

One of the most cellular responses to stress is rapid changes in gene expression in a group of proteins which is known as the heat shock proteins (HSP). The variety roles of HSP proteins are facilitate the integration of proteins [1] and handling and transfer of proteins [2] binding to damaged proteins and help to re-enable them, the repair and design of protein complexes [3], to prevent protein aggregation and analysis removing unstable proteins [4]. In addition, they have the potential to be as a sign that cellular damage and thus can be used for diagnostic and therapeutic purposes [5]. The heat shock proteins are classified according to molecular weight and function to small HSP, 40, 60, 70, 90 and 110 [6]. HSP70 plays a role in cell survival with the stability of the new cellular proteins. HSP70 proteins are similar, but body produces a variety of proteins tailored to stimulate. For example, the level of HSP70 is increased in variety of diseases [7]. One of the most important roles of immune system is predicting inflammation and pathogens in the body, which inflammatory agent does. Proteins which change plasma and serum of humans and animals in factors such as inflammation, necrosis, and infections of bacterial and viral call acute phase proteins (APP). The majority of these proteins reduce inflammatory lesions in tissue. Some research has been expressed, sports is a stimulus to create HSP [8, 9]. Results of some studies suggest that exercise as well as other stimulus leads to metabolic changes and producing HSP70, although some studies have reported no change or a decrease [3, 10]. The purpose of this study is including pressures affects and elevated temperatures on training individuals also coaches and athletes can be notified how much physical stress exist. Athletes have to exercise at different temperatures. Thus, the reaction of the body especially at the cellular level (HSP) and safety (CRP) in exercise time to exhaustion and the extent of different environmental conditions are essential.

Materials and Methods

In this clinical trial, 15 climbers (the criterion of at least 16 weeks to qualify regularly every week, at least 2,500 m ascent) and 15 non-athletes (the criterion of regular physical activity during the past 5 years) selected. At the start of the study and research of the implementation process shared fully in subjects then completed

satisfaction questionnaires. Subject in two different conditions did elect an aerobic test. This test is an aerobic test was performed using Monark bike. They began the test with 25 watts and 25 watts every minute of it, while adding that the track cycling to 90-100 rpm was maintained. When momentum less than 50 min to reach the level of exhaustion is reached [10] . Prior to the test subjects were in a natural condition and 24±2°C temperature and all blood sample was taken. They immediately elected to exhaustion aerobic tests performed and blood samples were taken again. A week later, the same people were in hot environment for one hour in 38±2°C and all subjects had blood samples. Finally, the test cases were run to exhaustion. The last blood sample was taken from them. Tools including kits for measuring HSP70 (SPA-812 & SPA-810 and Stressgen-Canada), kits for measuring CRP (model "Monobaynd"-America, with high sensitivity), Monark bike (Model E839-Sweden) Beurer scales with precision 0.1 kg and a temperature gauge (model GG0722-Iran), respectively. Comparison between the average and standard deviation of plasma concentration of heat shock protein (HSP) and C-reactive protein (CRP) before and after exercise in normal and hot environmental conditions associated with the use of *t*-test (paired sample *t*-test) were done. $p \leq 0.05$ as a significant level was considered and SPSS-16 statistical software was used.

Results

Average and standard deviation of weight, height and BMI of athletes and non-athletes at the beginning of the study are shown in table 1, a significant difference ($p<0.05$) in terms of these three variables were not observed between the two groups. Results showed, there is a significant differences between athletes and non athletes in the heat shock protein in the post-test and pre-test in both environments, ($p<0.05$). Athletes are also significant differences between the pre-test naturally and found in warm and hot environments HSP70 production rate is higher ($p=0.03$). Moreover, significant difference in post-test was seen in both environments ($p=0.032$). HSP70 levels after an hour in a warm area for about 65% more than the natural environment. Also, after the exercise test to exhaustion in high levels of stress proteins temperature is about 56% more than the natural environment. There were no significant changes in CRP plasma levels of athletes in warm and normal environment. We found different with consideration to CRP plasma level of athletes in both environment. Because the temperature in athletes from 0.93 to 0.94 mg/lit at temperatures from 1.3 to 1.4 mg/lit will be changed. Also there is no difference between HSP and CRP levels in non-athletes at warm and natural environment in the pre-test and post-test was observed (Table 2).

Table 1. Average and standard deviation of weight, height and BMI of athletes and non-athletes at the beginning of the study

Variable	Athletes	Non-athletes
Weight (Kg)	72.6 ±2.1	74.6 ±1.1
Height (cm)	177.8 ±1.2	178 ±2.4
BMI (Kg/m2)	23.17 ±1.1	24.29 ±1.8

Discussion

This study showed that the heat shock protein levels in athletes were significantly increased by exercise to exhaustion, but this change is more significant at warm environment. The results also demonstrated that there were no significant changes an increase in C-reactive protein. Heavy physical activity with metabolic disorders and cellular damage induced by exercise begin and adjustments in metabolism and transport processes, cellular repair and protein synthesis can begin. As mentioned, due to the different climatic conditions in our country, paying particular attention to the body's response to such situations is important. There are many situations which athletes in different circumstances have to do with its location in a severe contest which is usually associated with inflammation. In such circumstances, many of these events are thought to increase protein [10].

When you get to stress (physical activity) takes place cells of the body trying to protect itself, but the reaction requires the ability to do this [11]. Activity in several ways, including thermal, mechanical, oxidative metabolism can increase the amount of HSP70 in the cell. In fact, the amount of HSP70 in the organ of body after long and intense exercise training may improve [12]. Generally, increasing cell temperature is the primary factor of stimulating production of HSP70 [13].

Exercise and increasing the temperature of the body cause produce of HSP70 more rapidly [14]. In the present study due to significant changes in heat shock protein perhaps said that when the athlete's body faces to stress, cell's response is increasing to protect itself. The intensity and duration of exercise on HSP70 levels have been studied by many researchers; however, the relative intensity of exercise to increase HSP70 (potentially useful) is not well defined.

Table 2. Amount of heat shock proteins and C acute phase protein before and after exercise in male athletes and non-athletes

Groups	Heat shock protein (ng/ml)				Acute phase protein-C (mg/l)			
	22±2°C		38±2°C		22±2°C		38±2°C	
	Before	After	Before	After	Before	After	Before	After
Athlete	12.9±4.3	*24.2±15.2	37.2±32.5	*56.2±35.7	0.94±0.7	0.93±0.82	1.4±1.5	1.3±1.2
Non-athlete	12.4±3.9	12.7±7.8	17.14 ±12.6	19.06±14.1	0.88±0.56	0.75±0.64	0.91±0.8	0.94±0.44

*At the level of 0.05 means

In another study, it has been reported that HSP70 during exercise the muscle of the sailors has increased within 4 weeks, but in contrast, a training running on a treadmill for 3 hours after exercise does not increases the levels of these proteins [10-13].

Perhaps one of the reasons for the differences in the past and the present study is that running on a treadmill does in vitro, which is usually in appropriate conditions, temperature and pressure on the participants may not enter. Belter et al. studied in female rats after 6 days of running on a treadmill, they found HSP72 increased prior to exercise but increasing running on the treadmill has negative effect on the expression of HSP72 [3]. As the researchers stated with practice, HSP72 production dropped this means that with increasing levels of physical fitness, stress on the cells reduce although exercise is not changed. Ruell et al. were studied HSP72 levels in young runners with heat sickness symptoms induced by exercise (CNS) and the control group. Samples of venous blood within 10 minutes after the race were taken. The results showed that rectal temperature was higher in the CNS than in the other groups. HSP72 levels in the CNS patients with mild symptoms and control groups showed a significant increase. Also plasma levels in blood samples taken at rest (9 days after the race) were very low [12]. Results of several studies show that HSP70 responses depends on intensity of the differ exercise in humans.

Peake et al. in the same field chose 10 male runners. Subjects did two separate practices that included an hour of running on a treadmill with no incline intensity 60 and 85% VO^2max. HSP70 concentration increased immediately after exercise in both groups, and was characterized by moderate to high-intensity run a greater impact on increasing HSP70 is (on average 30% and intense workout 3.1 times) [9]. According to several studies, the reason of deferent results depends on; sports performance, fitness level of individuals, number of sessions, the ambient temperature, and the number of participants and duration of exercise sessions. But perhaps the most important is environmental temperature, especially when a hard competition has taken place. Claudia et al. were studied effects of resistance training on CRP inactive postmenopausal women. Training program consists of three workout sessions per week, each session lasting 60 to 75 minutes the two steps repeat 6 to 8 and 70 to 80% of one repetition maximum intensity was done.

In conclusion the researchers stated that resistance training is associated with lower serum CRP [11]. Haqq-Stevens in other research concluded that 12 weeks of endurance training increased insulin sensitivity in obese adolescents, while the significant changes in inflammatory factors such as CRP is not creation [15]. In a similar study, Hammett et al. examined the effects of 12 weeks of endurance training on inflammatory parameters of smokers and significant reduction in CRP and fibrinogen did not observe, however, significant progress in the fitness of subjects was seen [7]. Another study showed that aerobic exercise reduces the levels of WBC and CRP in obese men [16]. Also Debidi et al. were examined the affects of twelve weeks continuative exercise on C reactive protein of female Wistar rats. continuative trainings three to five times a week for 12 weeks with determined speed and duration were done. There was a significant increase in CRP values in the control group after six and twelve weeks, while the continuative training, both in the first six weeks of training, non-significant decrease was observed. On the other hand, CRP variation between the three groups showed there are significant differences between training groups 3 and 5 times in comparison with the control group, while there is no different between the two exercise groups. According to the results, researchers expressed effectiveness of exercise 5 times is more than exercise 3 times a week, but the inhibition of the inflammatory response, training during is important than the number of training at a week [17].

The findings of the present study indicated exposure for one hour at different temperatures can not cause significant changes in CRP, even if it is heat stress with exercise to exhaustion. Despite the non-significant findings may be because of the high CRP levels before and after the test performance in athletes than non-athletes, we can say athletes can tolerate further stress (temperature and activity to exhaustion). In connection with the study results are consistent with some other research, time, the number of individuals and number of sessions is noted. If the number or duration of exposure in environments changes thus results may vary. In order to perform similar studies suggest that the more time participants are exposed to different environmental temperatures, and it is better to study physical activity in different intensities. It may also athletes have more than one race at other weather Location, number of training sessions should increase. Perhaps this protection can be better in the body of athletes than non-athletes. In addition, when the athlete is placed against multiple stresses (high temperature and physical activity) are more significant and the reaction of cells of his body is better.

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Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest

The authors declare no conflict of interest.

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