

**THE EFFECT OF ONE BOUT RESISTANCE EXERCISE IN WARM ENVIRONMENT
ON SERUME IL-6 AND CORTISOL IN TRAINED FEMALES**

**MEHRNOOSH YADEGARI¹, SAKINEH ADIBI SADEH², MOHAMMAD
ALVANDIAN³, ZAHRA SHAMS⁴, OMID YAGHOOBPOOR YEKANI^{5*}**

1,2,3,4,5: Department of Exercise Physiology, faculty of physical education and sports sciences,
Islamic Azad University, Central Tehran Branch, Tehran, Iran

***Corresponding Author: E Mail: Omidyekani@yahoo.com; Ph.:+98 21880744905**

ABSTRACT

The aim of this study was to examine the effect of one bout resistance exercise in warm environment on serume IL-6, Cortisol in trained females. 14 students (Age 26 ± 1.2 years, Weight 59.28 ± 3.49 Kg, Height 164.2 ± 3.14 Cm) were chosen accidentally. The protocol include: Two sessions resistance exercise in two different environments, warm environment ($35\text{ }^{\circ}\text{C}$) and normal environment ($18\text{ }^{\circ}\text{C}$). The training sessions were separated to each other by 1 week. The blood samples were taken 1 hour before exercise, immediately and 1 hour after exercise. The Repetition variance (2×3) was used to statistical analyzing data. In conclusion warm environment increase significantly serum IL-6 and serum cortisol.

Key words: Resistance training, IL-6, Cortisol

INTRODUCTION

It is understood that the components of immune function are affected by physical Activity in an adverse environment. Although light physical activity even in the presence of adverse environmental conditions might promote a beneficial immune response, highly intense or

prolonged exercise and/or heat stress might actually elicit an immunosuppressed response similar to trauma or inflammation, which can in turn increase Susceptibility to viral infections [25].

Cytokines are of particular interest due to their roles in the balance of immune

responses between beneficial and harmful physiologic effects [1,10]. In particular, interleukin-6 (IL-6) has proinflammatory and anti-inflammatory properties [31,32]. In addition, IL-6 responds to many different modes, durations, and intensities of exercise or training and to endogenous and environmental stressors [23]. IL-6 increases measurably with exercise and heat stress and might be a valuable marker of stress and possibly of recovery [22].

Lim et al (???) found that levels of IL-6 acted as an anti-inflammatory cytokine in athletes exposed to tolerable heat levels [18]. Endocrine system plays an important role in maintaining the body integration and homeostasis. Catecholamines demarginate leukocytes and in turn cortisol causes cells to migrate to lymphoid tissue [29]. Literature suggests that a rise in core temperature by at least 1.2°C will elicit a rise in plasma cortisol levels [3,21]. It has also been demonstrated that warm stress affects the physiological response by secreting catecholamine's and cortisol [3]. Cortisol is a catabolic hormone and the most important antistress hormone in the body.

However, its increase in the long term causes some problems, the most important one relates to damaging the immune system and proteins [4]. The measurement of both

testosterone and cortisol has been suggested to be a possible endocrinological marker of the physiological stress associated with exercise [15]. Changes in the concentration of these hormones have been suggested to be indicators of the anabolic and catabolic activity occurring within the tissues [15].

A decrease in concentrations of testosterone, an increase in cortisol or a lowering of the testosterone to cortisol ratio may be related to an elevated catabolic activity. The results of the studies show that changes of cortisol depend on intensity and duration of exercise [8]. Cortisol has been shown to be quite sensitive to warm stress, especially when rectal temperature exceeds 38 °C [5,12]. Training in warm environment is more difficult than training in cold environment. Disturbance in sport capacity occurs when training in warm environments [14].

Nowadays athletes have to perform in environmental extremes (e.g. heat, cold, high altitude and microgravity) and need to resistance training for muscles hypertrophy. However, to date few studies report the resistance exercise induced IL-6 and cortisol responses in warm environment. Therefore, the aim of this study is to investigate the effect of one bout resistance exercise in warm environment on serum IL-6, Cortisol in trained females.

SUBJECTS AND METHODS**Subjects**

14 students of physical education (Age 26 ± 1.2 years, Weight 59.28 ± 3.49 Kg, Height 164.2 ± 3.14 Cm) accidentally selected. All of subjects were healthy and who did not have any precedence of chronic diseases. They were non smoker. Subjects avoided the use of medications known to affect immune system for 1 week before test sessions and nutritional supplements.

Experimental design

One week before experimental session subjects familiarized with Experimental design and height, weight, BMI were measured. Subjects were asked to report to the laboratory for an additional session designed to determine 1RM for eight exercises including squat, bench press, latissimus pull down, leg extension, triceps pushdown, leg curl, bench press, and back squat. All the subjects completed two experimental sessions. The two sessions were separated by at least one week. The experiments were performed in normal (18°C , 40%-50% relative humidity) and warm (35°C , 40%-50% relative humidity) environments. The warm up were performed for 15 minutes. The Circuit resistance exercise sessions included the performance of 3 sets of 10 repetitions at 70% of 1-RM

with 1 minute rest between sets and 5 minutes rests between Circuits.

Blood measurements

During each experiment session blood samples were obtained from antecubital vein 1 hour before exercise (before), immediately postexercise (after) and 1 hour postexercise (recovery). Plasma was separated by centrifugation (4000g, 5min). The samples were frozen and stored at -70°C for subsequent analyses. Plasma IL-6 and cortisol were determined by human ELISA kit (eBioscience, America).

Statistical analysis

Descriptive data are expressed as means \pm standard errors (SE). Normality of data was determined using kolmogrov-smirnov test. IL-6 and cortisol hormone values were analyzed by using a 2 (warm vs normal environment) \times 3 (1 hour before exercise, immediately postexercise, and 1hour postexercise measurements) repeated-measurements ANOVA. The level of significance was set at $P < 0.05$.

RESULTS

The mean and standard errors of IL-6 and cortisol 1 hour before exercise, immediately postexercise, and 1 hour postexercise are presented in Table 1.

The effects of one bout resistance exercise in normal and warm environment on plasma IL-

6 levels are presented in Fig 1. The significant interaction between time and the environments was observed ($F_{2,12}=0.731$, $P=0.008$). A significant main effect for time was found for IL-6 levels. IL-6 levels revealed significant increase at immediately postexercise and it showed decrease at 1hour postexercise in warm environment. IL-6 levels have changed at immediately postexercise but it decreased at 1hour postexercise in normal environment (Fig1). The effects of one bout resistance exercise in normal and warm environment on cortisol

levels are presented in Fig. 2. The significant interaction between time and the environments was observed ($F_{2,12}=44.78$, $P=0.000$). A significant main effect for time was found for cortisol levels. Cortisol levels revealed a highly significant increase at immediately postexercise and it Showed a highly decrease at 1hour postexercise in heat environment. Compared with immediately postexercise values in warm environment, increase of cortisol was lower than IL-6 and it had lower decrease to IL-6 (fig2).

Table 1: The mean and standard errors of IL-6 and cortisol 1 hour before exercise (before), immediately postexercise (after), and 1 hour postexercise (recovery)

Condition/ variable	1hour before exercise	Immediately postexercise	1 hour postexercise
Normal - IL-6(ng/ml)	8.93±2.26	8.94±2.08	6.72±1.11
Warm -IL-6(ng/ml)	6.16±0.77	8.49±1.11	6.74±0.59
Normal -Cortisol(ng/ml)	135.59±41.84	185.82±29.69	159.71±40.14
Warm - cortisol(ng/ml)	129.99±41.84	223.16±40.38	106.79±23.37

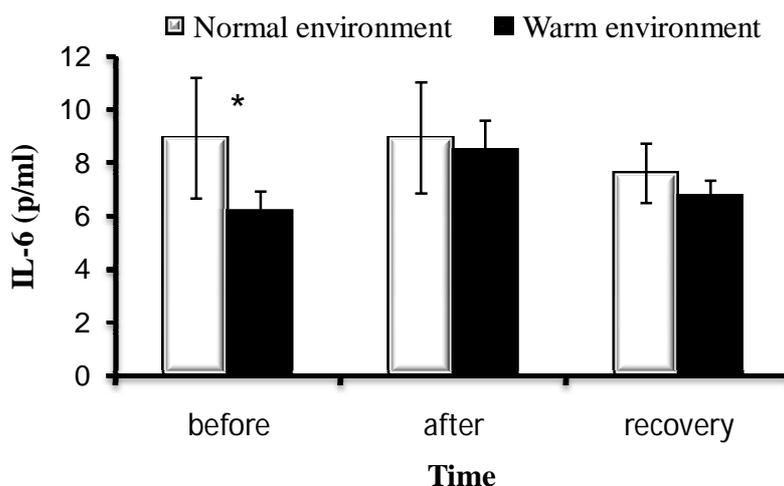


Fig 1: Mean (±SE) values of IL-6 levels at 1 hour before exercise, immediately postexercise, and 1 hour postexercise for both conditions

**Significant interaction of data's between two sessions.*

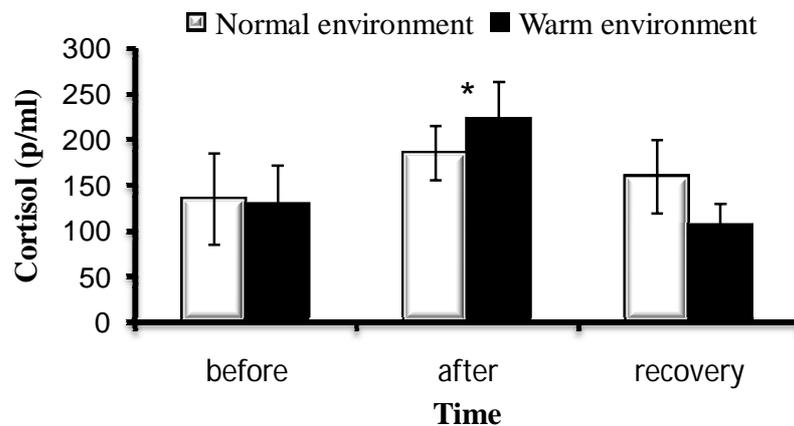


Fig 2: Mean (\pm SE) values of IL-6 levels at 1 hour before exercise, immediately postexercise, and 1 hour postexercise for both conditions

*Significant interaction of data's between two sessions.

DISCUSSION

The purpose of this study was to investigate the effects of one bout resistance exercise in natural and heat environment on plasma IL-6 levels and cortisol levels. IL-6 levels revealed significant increase at immediately postexercise and it showed decrease at 1 hour postexercise in heat environment.

IL-6 levels have changed at immediately postexercise but it decreased at 1 hour postexercise in normal environment. Cortisol levels revealed a highly significant increase at immediately postexercise and it showed a highly decrease at 1 hour postexercise in warm environment. Compared with immediately postexercise values in warm environment, increase of cortisol was lower than IL-6 and it had lower decrease to IL-6. In relation with no significant changes of IL-6 levels and cortisol levels in normal environments and increase of them at

immediately postexercise should say that in compared with exercise in normal environments, exercise in warm environments is associated with increased core temperature, cardiovascular drift, circulating stress hormones and catecholamines and an increased reliance on carbohydrate as a fuel source [7,9].

Evidence supports an interaction between neuroendocrine and immune responses to exercise [13]. Therefore, performing exercise in warm environments with associated elevated circulating stress hormones and catecholamines would be expected to cause greater immune disturbance compared with exercise in normal environments [20]. Exercise induced immune disturbances in normal environment [24] are often attributed to neuroendocrine responses and the rise in core temperature associated. Plasma IL-6 concentration has been shown to increase

after prolonged exercise with additional heat stress but remain unchanged when the exercise was performed in normal environments or cold environments [3,26].

The most likely source of the additional IL-6 after exercise and heat stress is skeletal muscle particularly as contracting skeletal muscle IL-6 production is raised when intramuscular glycogen stores are reduced and the reduction in intramuscular glycogen stores is exacerbated with raised muscle temperature and after exercise with additional heat stress [27]. It suggested that the response of cortisol may be more duration dependent and less intensity dependent [16]. It has been suggested that a short duration of exercise may not be sufficient to elicit a large adrenocortical response [30].

Cortisol has been shown to be quite sensitive to warm stress, especially when rectal temperature exceeds 38 °C [5]. Copeland et al (2002) reported to increase of testosterone and to decline of cortisol in response to resistance training and endurance training [6]. Hakkinen et al (1995) reported no change of testosterone and cortisol in response to resistance training and endurance training [11]. Wright et al (2012) evaluated to response of cortisol and IL-6 to 2-hour heavy intermittent exercise protocol (six 15-

min bouts of cycling at a constant rate of metabolic heat production interspersed by 5-min rest periods) in Heat/Dry (46°C, 10% relative humidity) and Warm/Humid (33°C, 60% relative humidity) environments (WBGT ~ 29°C). No differences existed for plasma protein concentration, and core temperature between the Heat/Dry and Warm/Humid conditions. IL-6 exhibited greater increases in the Heat/Dry compared with the Warm/Humid environment [33].

Ludmila et al (2011) studied to compare plasma differences in inflammatory cytokines including TNF- α and IL-6, in addition to the stress hormone cortisol, during prolonged cycling under normal (15°C and 40% relative humidity) and hot (35°C and 40% relative humidity) environmental conditions in elite cyclists. Total cortisol concentrations were elevated immediately postexercise and 12 h postexercise in both the normal and Heat environment. TNF- α concentrations were only significantly ($P = 0.045$) elevated postexercise in HOT environment. A significant difference in IL-6 was seen immediately after and 12 h postexercise in heat environment. During the normal environment, IL-6 was only significantly elevated postexercise ($P < 0.05$) [19]. Benini et al (2015) verify the acute effects of a full

body resistance exercise protocol on growth hormone (GH), testosterone (TT), cortisol, interleukin (IL)-6 and IL-10 in men and women. Both men and women had a similar increase in GH at immediately postexercise in response to exercise. In the men, an increase from pre was noted at immediately postexercise and 30 min for testosterone, cortisol and IL-6. In the women there was no change in TT, cortisol and IL-6 concentration [2]. Libardi et al (2012) evaluate the effects of 16 week of resistance training (RT), endurance training (ET), and concurrent training (CT) on inflammatory markers, C-reactive protein (CRP), and functional capacity in sedentary middle-age men [17]. Trenerry et al (2011) investigated the effects of 12 weeks resistance training on IL-6. 12 weeks resistance training increased IL-6 levels [32]. Hoffman et al (1996) examined the effects of intermittent high intensity exercise on testosterone, cortisol, and the ratio of testosterone to cortisol (T:C) blood concentration responses in different temperature. Eight active men (mean age 25 \pm 3 years) performed two series of five 15-s Wingate anaerobic power tests in both heat (H, 35°C) and thermoneutral (TN, 22°C) environments. A significant decrease in cortisol concentration was observed between pre exercise and immediately post exercise,

during both environments. Testosterone and the ratio of testosterone to cortisol (T:C) didn't have any changes. Testosterone and cortisol respond similarly to repeated periods of short duration high intensity exercise, in either thermoneutral or moderately heat environments [13].

Conclusion

According to the present data's, one bout resistance exercise in heat environment causes to increase serum IL-6 and cortisol levels. Physical activity induced increase of serum IL-6 levels causes to improve immune function.

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