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Effect of 8 Weeks Low and High Intensity Resistance Training on Leukocyte Count, Igg, Cortisol and Lactate Concentration in Untrained Men

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Abstract: The purpose of this study was to investigate the effect of 8 weeks resistance training with different intensity on leukocyte count, IgG, cortisol and lactate concentration in untrained men. 24 untrained male (aged 23.67±1.71 years; height 176.04±5.82 cm; weight 70.78±6.66 kg and body fat 15.82±2.47 percent) were selected and randomly divided into three groups: high-intensity (80%1RM)(n=8), low-intensity (50%1RM)(n=8) and control (n=8) groups. Resistance training program includes (bench press, military curl, arm curl, lat pull down, leg press and leg extension), with three sets and 7-8 repetitions in high-intensity group and 12-13 repetitions in low intensity group. Blood sampling were collected in pre-test, after 4th week and 8th week of training. Result showed that the leukocyte count and IgG concentration in 80%1RM (HI) group decreased significantly but Cortisol and Lactate concentration in HI group increased significantly. The leukocyte count and IgG concentration in 50%1RM (LI) group increased significantly but Cortisol concentration in LI group decreased significantly. According to our findings we concluded that HI resistance training lead to suppression of cellular immune system with decreased of leukocyte count and immunoglobulin G as one of the humeral immune parameters and increased cortisol concentrations.

Key words: Systemic and Humeral immune · Cortisol · Lactate · Immunosuppression · Resistance training

INTRODUCTION

Many studies have shown that various aspects of immune function are temporarily changed following exercise. Prolonged strenuous exercise temporary led to neurological, hormonal - immunity disorders, early fatigue and immune suppression that typically lasts for 3 to 24 h after exercise [1]. Exercise can have both positive and negative effects on immune function and susceptibility to minor illnesses. Cross-sectional studies that have compared leukocyte numbers and functions more than 24 h after their last training session in athletes with those of sedentary individuals have generally reported differences [2]. Gleeson *et al*. reported that long-term training on systemic and mucosal immunity was assessed prospectively in a cohort of elite Australian swimmers over a 7-month training season in preparation for national championships. The results indicated significant suppression of resting serum IgA and IgG concentration in athletes, associated with long-term training at an intensive level [3]. Some studies has been postulated that intense and prolonged exercise may be associated with a post-exercise window of opportunity for infection because of a decrease in the activity of natural killer as well as blood levels of immunoglobulin subgroups, increased concentrations of cortisol and cause the immunosuppression [4, 5]. High-intensity exercise causes tissue damage, production of stress hormones and alterations in the circulating quantity and function of various immune cells [6]. Klentrou *et al*. showed that the intense aerobic activity decrease the amount of immunoglobulins and sets the body exposed to injury, especially in the upper respiratory tract infection while the physical activity with average intensity causes the increase of IgA amount and diminish the danger of suffering from infection [7]. The relationship between susceptibility to URTI and exercise workload is modeled as a J-shaped curve. This model suggests that, while

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engaging in moderate activity may enhance immune function above sedentary levels, excessive amounts of prolonged, high-intensity exercise may impair immune function [2]. It has been proposed that metabolic stress (for example, exercise) stimulates the hypothalamic-pituitary-adrenal (HPA) axis, leading to an increased secretion of immunosuppressive hormones such as Adreno-Cortico-Trophic-Hormone (ACTH) and cortisol, consistent with the increased susceptibility to upper respiratory tract infections [8]. Changes in both concentrations and function of leukocytes are linked to the intensity and duration of exercise [9]. Also cortisol has been investigated in relation to exercise and its response may be related to the occurrence of immunosuppression in the post-exercise period [10]. The subjacent mechanisms are associated with the communication between the nervous, endocrine and immunological systems, suggesting autonomic ways and immune response modulation. Immune system cells, when exposed to small stress loads, develop tolerance mechanism [11]. Prolonged intense exercise training may cause reduced serum IgG levels; for example, clinically low IgG levels were observed in resting samples obtained from elite swimmers [3]. But, Neves *et al*. reported different intensities of resistance training on immunosuppression, showed that resistance training not effect on reducing the performance indicators immune subjects [12]. In addition, Nehlson-Cannarella *et al*. demonstrated that there were no significant differences in serum IgG after 15 weeks of moderate training in subjects [13]. Lactate is a key factor potentially contributing to the mechanism of the immune response to exercise that has yet to be investigated in this context. Immune cells produce lactate at sites of inflammation and the corresponding drop in pH modulates a number of immune responses [14]. Although the physiological mechanisms underlying the temporarily suppression various aspects of immune function after high intensity exercise are still unclear, it is likely that both neural and endocrine factors influence the immune response to exercise. Although the majority of exercise intervention studies focus on aerobic exercise as the model, there are a few studies that have examined resistance training as the mode of exercise [15]. Therefore, for public health reasons, it is necessary to know how the untrained individuals respond to the stress imposed by resistance exercise, because this type of exercise has been widely recommended for this population. Therefore, the aim of the present study was to investigate the effect of 8 weeks resistance training with different intensity on leukocyte count and IgG, cortisol and lactate concentration in untrained men.

MATHERIAL AND METHOD

The present study involved 24 untrained college men (age: 23.67±1.71 years, height: 176.04±5.82 cm, weight: 70.78±6.66 kg and body fat: 13.82±2.47 percent) volunteered for this study. Subjects complete and they signed an informed consent document after the investigation. The Institutional Review Board of the Guilan University of Iran approved the research protocol. The criteria of exclusion were following: recent fractures, uncontrolled hypertension, cardiovascular health and pulmonary disease, smoking, obesity, corticoid therapy, hormonal abnormal and lack of regular resistance exercise. Subjects, randomly divided into three groups: high-intensity (80% 1RM) (n=8), low-intensity (50%1RM) (n = 8) and control (n = 8) groups. The body composition was assessed by caliper for the cutaneous fold, which was the protocol used by Jackson and Pollock for men [16]. Maximal muscular power was determined through the maximal repetition test (1-RM), with a 3 minute interval of the following exercises: seated bench press, military curl, arm curl, lat pull-down, leg press and leg extension (Biodelta Equipments, Guilan, Iran) using the natural amplitude of the movement. The testing protocol has been described previously [17]. Testing consisted of two warm-up sets using three to five repetitions at 60 and 80% of estimated 1 RM followed by three to five subsequent attempts to determine 1 RM load. The highest load (kg) lifted with proper form, was used as the 1 RM test score [14]. Resistance training was performed 3 sessions per week for 8 weeks. Training sessions involved the following weight training on three sets (high- intensity (80% 1RM), 7-8 repetitions) and (low-intensity (50% 1RM), 12-13 repetitions) with 80 seconds rest between exercise and sets [12]. Amount of training volume equated by the formula (sets × repetitions × percentage 1RM) [12]. Exercise involved concentric and eccentric contractions and the time of any repetition was 2 seconds that was controlled for with metronome [18]. After an adaptation period to become familiar with the equipment and to ensure proper exercise techniques, participations underwent muscle strength assessment in each exercise of the training sessions.

7 ml of blood samples for leukocyte, IgG, cortisol and lactate analysis were collected after at least 12 hours fasting in three stages pre-test, after 4th week and 8th week of training period at 8 A.m. All participants were instructed to follow a standard menu in a fixed 24 hours schedule prior to the blood collection [18]. Leukocyte count were assayed from blood samples with anticoagulant (EDTA) using the Cell-Dyn 3500 automated

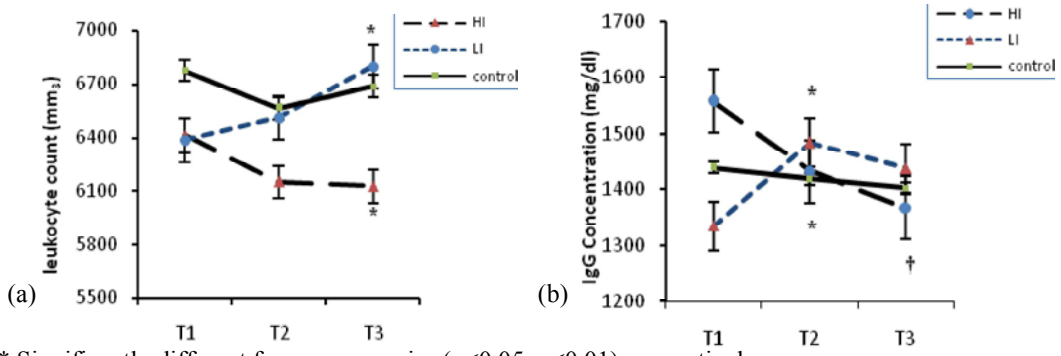
Table 1: Descriptive (mean ± SD) characteristic of the subjects

Participant characteristics	(mean ± SD)
Age (y)	23.67±1.71
Height (cm)	176.04±5.82
Weight (kg)	70.78±6.66
Body fat (%)	13.82±2.47

hematology analyzer (Abbott Diagnostics Division, Santa Clara, Calif). The Serum IgG was dosed through the Nephelometric technique with Bindingsite (commercial kits, UK). Serum cortisol was determined by enzyme-amplified Radioimmunoassay using the LKB gamma-counter (Diagnostics Products Corporation, Finland) and it's Immunotech (commercial kits, France). Blood lactate was analysis by colorimetric reaction with Eto-analyzer technique and it's Elitech (commercial kits, France). Normality of data distribution was assessed by the Kolmogorov-Smirnov test. A repeated-measures analysis of variance with Bonferoni adjustment was used to examine interasession differences for all the measured indexes of immune function. The results are presents as mean ± SD. The minimum threshold for statistical significance (P=0.05) and analysis were performed using the SPSS version 16.0 software.

RESULTS

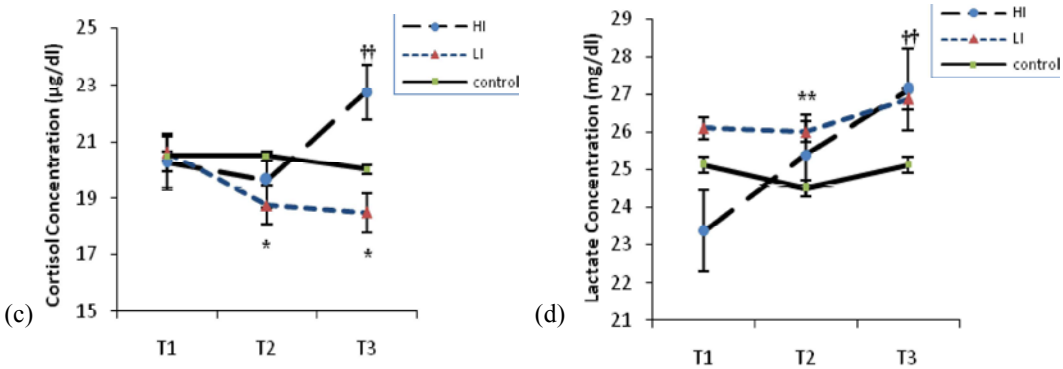
All participants were able to complete the experimental sessions and no injury was observed. Fig. 1-4 showed levels of blood leukocyte count, IgG, cortisol and lactate in the three stages after one week (T_1), after 4weeks (T_2) and 8 week's (T_3) training. Leukocyte count in 80%1RM group decreased significantly (4.5%) and in 50%1RM group increased significantly (6.5%) (Figure 1). IgG concentrations in 80%1RM group decreased significantly (14%) and in 50%1RM group increased significantly (7%) (Figure 2). Cortisol concentrations in 80%1RM group increased significantly (12%) and in 50%1RM group decreased significantly (11%) (Figure 3). Lactate concentrations in 80%1RM group increased significantly (14%). Also, lactate concentrations in 50%1RM group did not change significantly (Figure 4).



*, ** Significantly different from pre-exercise (p<0.05, p<0.01), respectively.

†, †† Significantly different from 4th weeks (p<0.05, p<0.01), respectively.

Fig 1, 2: Leukocyte count and IgG, concentration changes in Pre, Post 4th and 8th weeks.



*, ** Significantly different from pre-exercise (p<0.05, p<0.01), respectively.

†, †† Significantly different from 4th weeks (p<0.05, p<0.01), respectively.

Fig. 3, 4. Cortisol and Lactate concentration changes in Pre, Post 4th and 8th weeks.

DISCUSSION

The relationship between heavy aerobic exercise and the negative effects on immune function have been studied by researchers. The available findings showed the dual nature of immune response to exercise. Our findings showed that leukocyte count in 80%1RM group, decreased significantly, but in 50%1RM group leukocyte count increased significantly. Several mechanisms led to changes in leukocyte following exercise [19], Cortisol is stress hormone that cause changes in the lymphoid cells and was evaluated with increased exercise intensity [20] and overall increase in total circulating leukocyte counts, as well as increase in the various leukocyte subpopulations, as response to exercise [21]. Also the number of leucocytes that can be mobilized during resistance exercise is associated with the anaerobic exercise intensity as reflected by lactate production [14]. Maximal aerobic exercise led to increased leukocyte count, but immune responses not showed by resistance exercise [6]. Natale *et al*. reported that the leukocyte count increased after the different intensity aerobic exercise. Also, David *et al*. showed that low-intensity resistance training did not change leukocyte count significantly. Intensity and type of training, fitness level and cortisol concentration can determine changes in leukocyte count. Short-term high intensity exercise can change metabolic and hormonal mechanisms and led to immunosuppression [22]. Bermon *et al*. observed that 8 weeks of resistance training cannot affect leukocyte count of sedentary individuals [23].

High-intensity resistance training reduced serum IgG (S-IgG) concentration and low-intensity resistance training increased S-IgG concentration. Nieman *et al*. reported that low intensity exercise causing 20% increase in serum immunoglobulin levels during the 15 weeks exercise. These increases in immunoglobulin levels prevent infection [24, 25]. Stress hormones such as cortisol cause immunosuppression considered after heavy physical exercise [26]. Also, concentration of lactate is affective on antibodies [27]. Klentrou *et al*. have shown that vigorous aerobic exercise reduced the amount of IgG; leading to deal with injuries [7]. Cortisol concentrations increased following high-intensity resistance exercise but reduced during low-intensity resistance training. Serum cortisol levels increased in high intensity and prolonged exercise and the amount of immunoglobulin decrease due to increased activity HPA axis [10]. Exercise intensity more than 60%1RM cause increase cortisol concentration significantly [28]. Post-exercise cortisol concentration changes seems to be affected by several mechanisms: stimulation of sympathetic nervous system, stimulation of hypothalamic-pituitary-adrenal (HPA) secretion, increase of body temperature, changes in blood pH, hypoxia, lactate accumulation and mental stress [8]. The immune and endocrinological responses to exercise are dependent on its intensity and duration [6,8]. Yazdanparast *et al*. were assessed the effect of low, moderate and high intensity exercise on cortisol concentrations. Highest concentration of cortisol was showed in the high intensity exercise and the lowest concentration of cortisol in the moderate intensity exercise [29, 30]. High-intensity resistance training led to increased lactate concentration, while low intensity resistance training has no significant effect on lactate concentration. Blood lactate levels after the high-intensity exercise increase more than low intensity exercise and this increase is due to release lactate in muscle into the blood. The findings of this study show that the increase of lactate at the end of exercise can cause high levels of cortisol during recovery. Lactate has an influence on immune cells and appears to be a component of some immune responses. Neutrophils produce lactate at sites of inflammation as a means of lowering pH and luring additional cells to the site of inflammation [14]. Also, Stupinck *et al*. confirmed the relationship between lactate concentration and cortisol ($r = 0.515$) and reported that increased lactate levels in the end of exercise has been affected on high levels of cortisol. Thus, cortisol concentration after exercise was effected on anaerobic metabolism glycolysis [31]. Kraemer *et al*. reported that heavy resistance exercise lead to increased blood lactate concentration significantly. Lactate influence on immune system cells and appear some immune reactions and can be mobilized during resistance training is associated with the anaerobic exercise intensity as reflected by lactate production [14].

CONCLUSION

According to the findings of this study it can be concluded that high intensity resistance training led to suppression of cellular immune system with decreased of leukocyte count and cortisol concentrations and reduced immunoglobulin G as one of the humoral immune parameters. The results showed that low-intensity resistance exercise strengthen the immune system. Therefore, considering the limitations of this study we can conclude that low intensity resistance training has beneficial effects on immune function in untrained males.

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