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Comparing Levels of Serum IgA, IgG, IgM and Cortisol in the Professional Bodybuilding Athletes and Non-Athletes

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Abstract

Background: Bodybuilding athlete's bodies are placed under much pressure in during the exercise, which is causing changes in the immune and hormone system in the long term. The purpose of this study was to compare levels of serum immunoglobulin A (IgA), immunoglobulin G (IgG), immunoglobulin M (IgM) and cortisol in the professional bodybuilding athletes (BA) and the non-athletes (NA) male.

Materials and Methods: This study was a descriptive-analytic and 29 volunteer subjects in the professional BA and NA men participated. Levels of serum IgA, IgG, IgM using Single Radial Immunodiffusion (SRID) and levels of serum cortisol using Radioimmunoassay (RIA) were measured with blood sampling from brachial vein at rest and fasting. Data were analyzed using the Mann-Whitney *U*-test ($p<0.05$).

Results: There were not any significant differences between the mean levels of serum IgA, IgG, IgM in the BA than the NA ($p>0.05$), while, the levels of serum cortisol (22.10±2.60 vs. 15.41±3.44 µg/dl, $U=0.001$, $p=0.001$) significantly greater in the BA than the NA.

Conclusion: The results of this study showed that participation in training and competitions bodybuilding has no effect on serum levels of IgG, IgA, IgM, but increased levels of serum cortisol.

Introduction

Sport and physical activity has twofold effects on the strength and efficiency of the immune system of athletes [1]. The extent of these effects on the immune system depends the intensity, duration, and type of physical activity [2]. Strenuous exercise can cause suppression of mucosal immune parameters [3]. As a result, salivary IgA and IgM levels decrease specially IgA_1, increasing the risk of respiratory diseases [4]. In addition, increased release of stress hormones such as cortisol as a result of strenuous exercise can suppress the immune system and lead to upper respiratory tract infection in athletes [5]. In fact, the exercise-induced immunosuppression effects are largely related to circulating cortisol [6]. This suggests an interaction between exercise and the nervous system, the endocrine system, and the immune system [7].

Studies on the effect of exercise on immunoglobulin and cortisol has shown that strenuous exercise leads to reduced IgA and increased cortisol concentration and as a result weakens the immune system [8]. Other studies have reported that IgA concentration increases after exercise [9, 10], while salivary cortisol concentration decreases [11]. There are also studies that have shown that immunoglobulin and cortisol levels do not change after strenuous exercise [12, 13]. This suggests the contradictory results for the effect of exercise on the changes in the immune and endocrine systems. Although there have been several studies regarding the exercise-induced changes in the immune and endocrine systems [3, 5, 8-13], less attention has been paid to the effect of exercise on immunoglobulin changes and cortisol responses in professional bodybuilding athletes (BA). Professional BA are put under much pressure when performing exercises or weight training and this can lead to changes in the immune and endocrine systems in the long term. Thus, it is imperative to identify these changes considering the specific type of exercise they perform and the physical and mental stresses that accompany this sport. Understanding these effects gives us a deeper insight into physiological mechanisms and biological responses involved in this sport.

Therefore, the purpose of this study was to compare levels of serum IgA, IgG, IgM and cortisol in the professional BA and non-athletes (NA) male. We assumed that the pressure of weight training in BA vs. the sedentariness of NA can lead to changes in the resting immunoglobulin and cortisol levels in the long term.

Materials and Methods

The present research was descriptive-analytical. The population consisted of male, professional BA with a title in the national tournaments, with at least 5 years of training experience, and with 18 hours of regular exercise per week. The NA did not engage in any (Table 1) regular exercise or sport (demographic information). The sample included 29 volunteers who were physically and mentally healthy without any pulmonary, cardiovascular, infective, allergic, immunological diseases or hormonal disorders since one month prior to the study. They also had not consumed any supplements from 72 hours to one week before the study.

The validity of the questionnaire was verified by ten sports medicine experts. A day after the competition, the questionnaire reliability was calculated using 20 subjects and cronbach's alpha of 0.82. The subjects were then assigned to an experimental group or BA (N=14, age 24.43±1.80 years, height 177.69±9.95 cm, weight 81.43±4.66 kg) and a control group or NA (N=15, age 26.83±3.80 years, height 175.63±4.95 cm, weight 77.63±10.66 kg). The subjects filled out a consent form after becoming familiar with the research procedure.

The age, height, and weight of the subjects were recorded one day before the tests. Age was elicited through the questionnaire by year. Height was recorded in centimeters (with 1 mm accuracy) and their weight was measured in kilograms using Seca 220 medical scale (Germany).

The Levels of serum IgA, IgG, and IgM were measured by SRID using Baharafshan Kit (Iran) and the levels of serum cortisol were measured by RIA using RADIM kit (Italy) and by blood sampling (10 cc) from the arm vein in resting and fasting condition. Then, the blood samples were quickly centrifuged by lab scientists; after separating the serum, it was transferred into certain tubes which were kept at -20°C for further tests (measurement of the resting levels of IgA, IgG, and IgM).

Descriptive statistics were used in order to calculate the measures of central tendency (mean) and dispersion (standard deviation) of the variables. Kolmogorov-Smirnov test was applied to examine the natural distribution of the data. Due to the unnatural data distribution, a non-parametric test (Mann-Whitney *U* test) was used to compare the means of BA and NA. All the tests were done at 5% significance level using SPSS-16.

Results

The general characteristics of the subjects showed that the subjects in the professional BA were taller (177.69±9.95 cm vs. 175.63±4.95 cm) and heavier (81.43±4.66 kg vs. 77.63±10.66 kg) that the subjects in the NA. However, the mean age of professional BA was less than NA (24.43±1.80 years vs. 26.83±3.80 years) (Table 1).

Between-group comparisons revealed that there is no significant difference between the professional BA and the NA in the resting levels of serum IgA (366.64±27.98 mg/dl vs. 351.46±111.95 mg/dl; *U*=97.500; *p*=0.743), IgG (1559.21±139.62 mg/dl vs. 1632.80±125.87 mg/dl; *U*=63; *p*=0.066) (Table 2), and IgM (156.50±19.44 mg/dl vs. 163.33±13.92 mg/dl; *U*=-70.500; *p*=0.129). Moreover, the resting levels of serum cortisol was significantly higher in professional BA than NA (22.10±2.60 μg/dl vs. 15.41±3.44 μg/dl; *U*=0.001; *p*=0.001) (Table 2).

Table 1. The general characteristics of the subje

Variable	Group	
	BA (N=14)	NA (N=15)
Age (yr)	24.43±1.80	26.83±1.80
Height (cm)	177.69±9.95	175.63±4.95
Weight (kg)	81.43±4.66	77.63±10.66

Bodybuilding Athletes (BA), Non-Athletes (NA); Data are presented as the Mean±SD.

Table 2. Comparison of the levels of serum IgA, IgG, IgM and cortisol in bodybuilding athletes and non-athletes

Variable	Group		*U*	*p*-Value
	BA (Mean±SD)	NA (Mean±SD)		
IgA (mg/dl)	366.64±27.98	351.46±11.95	97.500	0.743
IgG (mg/dl)	1559.21±139.62	1632.80±125.87	63.000	0.066
IgM (mg/dl)	156.50±19.44	163.33±13.92	70.500	0.129
Cortisol (ug/dl)	22.10±2.60	15.41±3.44	0.001	0.000*

Notes: * denotes significance at *p*<0.001; Bodybuilding Athletes (BA), Non-Athletes (NA).

Discussion

The purpose of this study was to compare levels of serum IgA, IgG, IgM and cortisol in the professional BA and NA male. The findings showed that years of weight training has had no significant effect on the resting levels of serum IgA, IgG, and IgM of the professional BA as compared to the NA, while the resting levels of serum cortisol was significantly higher in professional BA than NA.

Sports and physical activity are factors that can improve the performance of many physiological systems of the body [14]. The immune system can adapt to exercise like other systems of the body such as the circulatory, respiratory, nervous, and muscular systems [15]. Our study showed that there is no significant difference between professional BA and NA in the resting levels of serum IgA, IgG, and IgM. Kajiura et al. studied 12 runners in four phases of running and came to the conclusion that intensity of exercise has no significant effect on serum IgA, IgG, and IgM levels [16]. It is possible that the humeral immune system of the subjects had adapted to exercise before they participated in this study. It has been shown that the resting serum immunoglobulin concentration of athletes of different sports is not significantly different from that of NA [17, 18], which is in line with the findings of the present research. Wit reported low IgA, high IgG, and natural IgM concentrations in athletes relative to NA [19], which is inconsistent with the present research. The possible reason for such an inconsistency could be difference in age, gender, intensity and duration of exercise, and the initial fitness of the subjects. In general, the findings of past studies and the present research suggest that changes in the immune system depend on the duration, intensity, and type of exercise, age and fitness of the subjects, and other factors (e.g. blood sampling method, measurements, and such) [7, 20-23]. There are various mechanisms for the effect of exercise on the concentration of antibodies.

Difference in antibody secretion (<10%) is one of the possible mechanisms for changes in the concentration of antibodies. In other words, these changes could be due to the exchange between intravascular and extravascular compartments. Nonetheless, lymph flow is stimulated by exercise and increased lymph flow rate can increase the flux of different proteins into circulation [24]. IgG has a longer half-life than IgM and its catabolism increases with its serum concentration; therefore, in a short period of time the level of IgG may not increase as much as IgM. Thus, less IgG concentration is followed by a relatively higher catabolism. Exercise intensity and duration are regulating factors that change the concentration of serum antibodies through complex mechanisms [25]. Moreover, the rate of lymphocytes in the circulation and lymphoid tissues, the number and sensitivity of lymphocyte receptors, and lactate concentration (2.56±0.29 mg/dl) are other moderating factors in antibody concentration. Also the interaction of sympathetic adrenergic nerves with the immune system in strenuous exercises affects the synthesis of antibodies and increases the number of β-adrenergic receptors in lymphocyte membranes. Antigenic stimulation against microorganisms that enter the body due to increased ventilation increases the level of antibodies [22].

The results of our study showed that the mean resting levels of serum cortisol was significantly higher in professional BA than NA. However, some other studies on the effect of strenuous exercises on serum cortisol have reported different results. Flynn et al. studied the hormonal responses of distance runners (21-30 yr) to excessive training. The results showed that there was no significant difference between the two groups in cortisol levels [26]. Kajiura et al. studied 12 runners in four 10-days training phases. Although there were individual differences in cortisol response following different phases, the mean cortisol concentration was not affected by the volume and intensity of exercises [16]. The present study is consistent with Buono et al., Kern et al., and Shinkai et al. [27-29], but inconsistent with the findings of Kajiura et al. and Flynn et al. [16, 26]. Various mechanisms have been introduced for increased cortisol concentration following an exercise session. The first mechanism is increased hormone secretion from the adrenal gland. Stimulation of the hypothalamic-pituitary-adrenal axis and increased secretion of ACTH from the pituitary are the most important factors in stimulation of cortisol secretion. During physical exercise, the HPA axis is activated and cortisol secretion increases.

Cortisol is a stress hormone that is released from the adrenal gland in response to stress; it strengthens the effect of catecholamine and one of the most important stimulants of cortisol secretion is strenuous physical exercise [30, 31]. The intensity of exercise is an important driving factor that affects the HPA axis. For activation of this axis, intensity of exercise must be up to a certain threshold that is very close to cortisol secretion threshold and is linked to anaerobic threshold [26, 30, 31]. Cortisol response to exercise also depends on the aerobic or anaerobic nature of the exercise [30, 32]. One of the possible reasons for change in cortisol concentration of athletes is the relationship between lactate concentration and cortisol level. Increased lactate concentration at the end of exercise and competition leads to high cortisol concentration in the recovery and resting period [33, 34].

Nonetheless, the results of studies carried out on exercise-induced changes in the immune and endocrine systems are contradictory and these contradictions are probably due to differences in training protocols (e.g. intensity, duration, and resting) and the characteristics of subjects (e.g. age, gender, and physical fitness) [25]. Now most researchers have accepted that exercise is a physiological stress that can change the proliferation of B lymphocytes through changes in neuroendocrine and metabolic factors and can affect the level of serum immunoglobulin [35].

In sum, it appears that long-term physical exercise in professional male BA does not lead to a significant change in resting levels of serum IgA, IgG, and IgM as compared to sedentary NA. However, our data suggest that participation in training and competitions bodybuilding has no effect on serum levels of IgG, IgA, IgM, but increased levels of serum cortisol.

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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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