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SERUM IMMUNOGLOBULIN PROFILE IN HIGHLY TRAINED PUBESCENT ATHLETES

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ABSTRACT

The immune system has been proved to respond to increased physical activity, which can account for the exercise-related reduction of morbidity. On the other hand, intense exercises have repeatedly been shown to cause immunosuppression. This type of immune response is investigated in a great number of studies unlike the effect of long-term training on the immune function. The aim of the present study was to assess the immune status by measuring the serum IgA, IgG, and IgM concentrations of young healthy athletes practicing different sports, and compare the results obtained with those of a control, non-trained group. Blood samples were taken from 582 highly trained sportsmen (age, 14.0 ± 0.1 years; weight, 56.4 ± 0.5 kg; height, 164.9 ± 0.5 cm), practicing seven groups of sports disciplines: track-and-field anthletics (n = 66), swimming (n = 70), rowing (n = 143), wrestling (n = 149), weight lifting (n = 40), sport games (n = 90), and other sports (n = 24). Length of sports practice was 3.4 ± 0.1 years. These subjects trained 90 minutes twice a day, five days a week. The control group consisted of 61 non-trained subjects (age, 14.1 ± 0.1 years). The samples were drawn from the cubital vein at rest and then the IgA, IgG and IgM concentrations (g/l) were determined. Serum IgA concentrations in sportsmen were found to be higher than those in the control group (1.96 ± 0.03 vs. 1.39 ± 0.10 g/l, $p < 0.001$), whereas the opposite was true for the IgM

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levels - they were higher in the non-trained control group (1.23 ± 0.09 vs. 1.05 ± 0.02 g/l, p<0.01). The serum IgG levels were higher in the blood samples obtained from the trained group (12.37 ± 0.16 vs. 11.06 ± 044 g/l, p<0.01). The mean values of all subgroups of sportsmen were found to be within the normal ranges. The highest IgA concentrations were found in track-and-field athletes, and the lowest ones in swimmers. The highest concentrations of IgM were also found in track-and-field athletes, and the lowest ones in weight lifters. The highest concentrations of IgG were measured in sportsmen from the sports game subgroup, and the lowest ones in wrestlers. In conclusion, the data obtained confirmed the direct link between long-term physical training at pubescence and the serum immunoglobulin pattern.

Keywords: Immunity, immunoglobulins, exercise, pubescence, sport

ÖZET

İLERİ DERECEDE ANTRENE ADOLESAN SPORCULARDA SERUM İMMÜNOGLOBÜLİN PROFİLLERİ

Artan fiziksel aktiviteye immün sistemin cevabı kanıtlanmış olup bu durum egzersize bağlı morbidite düşüşünden sorumludur denebilir. Diğer taraftan, şiddetli egzersizin çoğu kez immünosuppresyona yolaçtığı da gösterilmiştir. Akut tipte immün cevap pek çok çalışmada incelenmişken, uzun süreli antrenmanın immün fonksiyona etkisi fazla araştırılmamıştır. Bu çalışmanın amacı değişik spor branşlarında çalışan sağlıklı genç sporcuların serum IgA, IgG ve IgM düzeylerini ölçerek immün durumlarının değerlendirilmesi ve bunları antrene olmayan bir kontrol grubunun kilerle karşılaştırmaktı. Kan örnekleri yedi değişik spor türünü uygulayan ve çok iyi antrene 582 sporcudan (14.0 ± 0.1 yaş, 56.4 ± 0.5 kg ağırlık, 164.9 ± 0.5 cm boy) alındı: 66 atlet, 70 yüzücü, 143 kürek sporcusu, 149 güreşçi, 40 halterci, 90 takım sporcusu ve 24 diğer spor türleri. Spor geçmişleri 3.4 ± 0.1 yıl idi ve günde iki defa 90 dk olmak üzere haftada beş gün antrenman yapıyorlardı. Kontrol grubu antrene olmayan 61 bireyden (14.1 ± 0.1 yaş) oluşuyordu. Örnekler dinlenmede kübital venden alındı ve serum IgA, IgG ve IgM konsantrasyonları (g/l) belirlendi. Sporcuların serum IgA konsantrasyonları kontrollardan yüksek (1.96 ± 0.03 ve 1.39 ± 0.10 g/l, p<0.001) bulunurken IgM düzeyleri için tersi geçerliydi (1.05 ± 0.02 g/l' ye karşı 1.23 ± 0.09 g/l, p<0.01). Serum IgG

düzeyleri de sporcularda daha yüksekti (12.37 ± 0.16' ya karşı 11.06 ± 0.44 g/l, p<0.01). Bütün branşlardaki sporcuların ortalama değerleri normal sınırlarda kalıyordu. En yüksek IgA ve IgM değerleri atletlerde bulunurken en düşük IgA değerleri yüzücülere; en düşük IgM değerleri ise haltercilere aitti. En yüksek IgG konsantrasyonları takım sporcularında saptanırken bu açıdan en düşük değerler güreşçilerde belirlendi. Sonuç olarak bu veriler adolesanlarda uzun süreli antrenmanla serum immünoglobülin profili arasındaki direkt bağlantıyı ortaya koydu.

Anahtar sözcükler: *İmmünite, immünoglobülinler, egzersiz, adolesans, spor branşları*

INTRODUCTION

Increased physical activity is known to have an effect on the immune system. The available data on this subject are contradictory: Exercise is reported to stimulate the immunity (both non-specific and specific), reducing the risk of acute inflammatory disorders, but there have also been reports of immunodepression induced by intensive physical activity which can account for the fact that actively training athletes have a higher morbidity from infectious diseases, particullarly from acute respiratory disorders, than non-trained subjects (22). In reality, however, the response of the immune system depends on many factors including the individual's fitness level, type (acute or chronic) of training, intensity and duration of the physical activity (6,25). A number of studies, for example, which involve both trained and non-trained subjects, indicate that serum immunoglobulin concentrations are little affected by acute physical activity (1,3,21,24). In other studies, a considerable transitory suppression of the immune system is found, detected by the reduction of the serum immunoglobulin concentrations and the secretory rate of salivary IgA (5,9,12,14,20). In yet other studies, the findings indicate an increase of the concentration of some or all subclasses of serum immunoglobulins as a result of an acute single-bout physical exercise (6,18,20).

The prevailing view, however, is that a single-bout exercise is associated, in most cases, with reduction of immune reactivity. Initiation of a new bout of exercise after a relatively short period of time usually catches the immune system still depressed, thus athletes that train daily, regardless of the duration and intensity o training, have

permanent lower of immunoglobulins in their serum in comparison with nontrained subjects (22). In such cases, after competitions or training sessions continuing for several days, the production of salivary secretory immunoglobulin A drops down (11,26,27). As no changes are found in the amount of B-cells after the exercise, it is assumed that their ability to produce IgA, IgG and IgM is impaired, and the production of these immunoglobulins decreases. Hence the conclusion is that the suppression of humoral immunity has an entirely functional nature (22).

On the other hand, Nielsen et al. (19) showed that acute intensive exercise involving large muscle groups does not cause alone immunosuppression, but induces a manifest immune respose if repeated.

Unlike the effect of acute exercise on the immune status, there are comparatively few studies on the changes occuring in the immune system as a result of chronic exercises of the type usual for actively training sportsmen of different ages in the course of their preparation. Some longitudinal studies show a decrease of the serum concentrations of IgA, IgG and IgM (2,4,10,23) or the secretion rate of secretory sIgA, an important protector of the mucus of the upper respiratory paths against infectious agents (13). Other longitudinal studies, however, find no effect of chronic exercise on the humoral immunity of man (16,24) and experimental animals (8). There are even studies showing that the concentration of serum immunoglobulins increase as a result of chronic physical exercises (15,17).

The impact of chronic exercise on immunity is also well studied in cross-sectional studies in which the parameters of immunity of subjects actively engaged in training for a long period of time are compared with those of non-trained sedentary subjects. But these studies focus mainly on the differences between the neutrophil function, the natural killer cell activity or the lymphocyte proliferative response in trained or non-trained subjects.

There are few studies treating comparatively the serum concentrations of immunoglobulins. We could not find in the available literature any comparative analysis of the serum immunoglobulin concentrations in pubescent subjects training actively in the long-term and non-trained controls.

The aim of the present study was to assess some of the parametrs of the immune status by comparing serum IgA, IgG and IgM concentrations in a large sample of highly trained pubescent sportsmen practicing different types of sports with those of non-trained controls and searching correlations between their values and the type of exercise specific for the given sport.

MATERIAL and METHODS

Subjects: We included in the study 582 highly trained athletes recruited from the specialised sports schools in Bulgaria (age 14.1 ± 0.1 years, height 164.9 ± 0.5 cm, body weight 56.4 ± 0.5 kg, duration of sport spactice 3.4 ± 0.1 years, all values mean ± SEM). They were allocated to seven subgroups according to the sport practiced: track-and-field athletes (n = 66), swimmers (n = 70), rowers (n = 143), wrestlers (n = 149), weight lifters (n = 40), sports game athletes (playing volleyball, basketball, handball) (n = 90) and athletes practicing other sports such as gymnastics, rhythmic gymnastics, acrobatics, table tennis and court tennis (n = 24).

The control group consisted of 61 non-trained young people (age 14.1 ± 0.1 years, body weight 57.0 ± 0.2 kg, height 163.8 ± 0.4 cm). There were no differences in the values of these parameters between the experimental and control groups (Table 1).

Table 1. General characteristis of the highly-trained groups and the non-trained control group (mean ± SEM).

Characteristic	Highly trained group	Non-trained group	Difference of means
1. Age (years)	14.0 ± 0.1	14.1 ± 0.1	NS
2. Weight (kg)	56.4 ± 0.5	57.0 ± 0.2	NS
3. Height (cm)	164.9 ± 0.5	163.8 ± 0.4	NS
4. Sports practice (years)	3.4 ± 0.1	-	0.001

The athletes trained five days a week, twice a day, 90 minutes each time. The physical activity of the control group in the last 3-4 years was 90 minutes weekly (twice 45 minutes) - moderate exercise in the classes of physical culture at the schools.

Serum immunoglobulins: Venous blood samples were drawn from the cubital vein between 7:00 and 9:00 in the morning in accordance with the EPTRV and IFCC rules (7), after 48 h rest following the last exercise bout. The samples were obtained and collected using Sarstedt (Germany) closed-system needles and tubes with K_3-EDTA. Serum concentrations of IgA, IgM and IgG were determined by the method of immune precipitation on polyethylene glycol (PEG) with chemical analyzer Optima (Kone, Finland) at 340 nm. Kits, containing anti-IgA, anti-IgM and anti-IgG antibodies were used (cat. No 981231, 981232 and 981233, respectively).

Statistics: Statistical indices were computed for each group and subgroup and for all parameters (StatView 4.51 statistical software, Abacus Concept Inc., USA). ANOVA factorial analysis was carried out to evaluate the significance of all found differences. All data are presented as mean±SEM.

RESULTS AND DISCUSSION

Serum IgA concentration was found to be higher in the athletes than in the non-trained control group (1.96 ± 0.03 g/l vs. 1.39 ± 0.10 g/l, $p<0.001$) (Fig. 1). This parameter was significantly higher in all subgroups, with the exception of swimmers, in comparison with the control group, the highest concentration being found in the track-and-field athletes (Table 2). It exceeded twice the value found for the control group ($p<0.001$). The subgroup of other sports had higher values by 59.0% ($p<0.001$). The rowers and the sportsmen practicing sports games had higher serum IgA concentrations than the control group by 47.5% and 44.6% ($p<0.001$), respectively, without being different from one another. Athletes practicing strength sports (wrestling and weight lifting) had higher values by 27.3% and 23.0%, respectively, than those of the controls ($p<0.001$ and $p<0.05$), also without any differences between them.

The distribution of serum IgA concentrations in the different subgroups is presented in Fig 2. In all subgroups, as well as in the control group, serum IgA concentration was within the reference range for this age (0.7 - 4.5 g/l). Not a single case was found to have this parameter outside this given range.

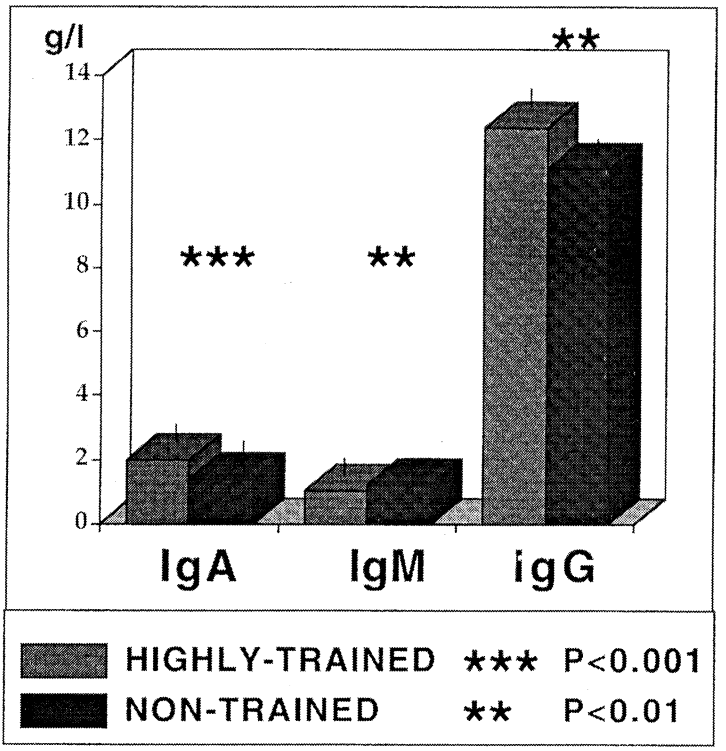

Figure 1. Serum immunoglobulin concentrations in highly trained and non-trained groups.

Table 2. Serum IgA, IgM and IgG concentrations in the highly-trained subgroups and in the non-trained controls (mean ± SEM).

Sport	IgA (g/l)	IgM (g/l)	IgG (g/l)
1. Athletics (n = 60)	2.67 ± 0.12	1.17 ± 0.05	12.80 ± 0.52
2. Swimming (n = 70)	1.48 ± 0.09	1.02 ± 0.05	12.75 ± 0.47
3. Rowing (n = 143)	2.05 ± 0.07	0.96 ± 0.03	12.24 ± 0.32
4. Wrestling (n = 149)	1.77 ± 0.06	1.05 ± 0.02	11.30 ± 0.29
5. Weight-lifting (n = 40)	1.71 ± 0.07	0.99 ± 0.55	12.52 ± 0.76
6. Sports games (n = 90)	2.01 ± 0.08	1.08 ± 0.04	13.31 ± 0.33
7. Other sports (n = 24)	2.21 ± 0.21	1.35 ± 0.08	13.81 ± 0.92
8. Controls (n = 61)	1.39 ± 0.10	1.23 ± 0.09	11.06 ± 0.44

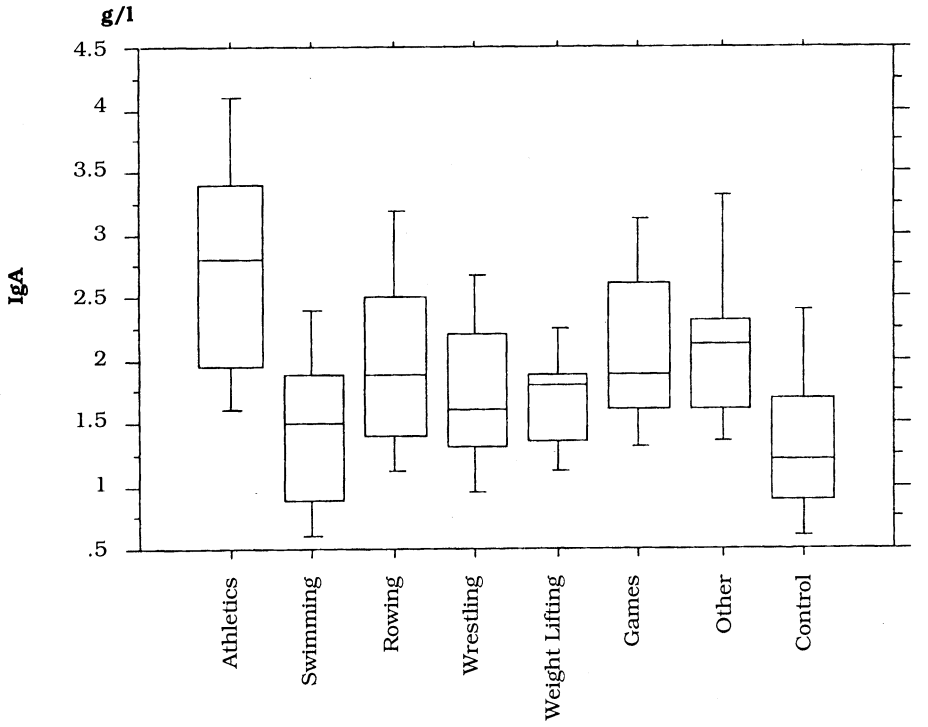

Figure 2. Distribution of the values of serum IgA concentrations in the highly-trained subgroups and in the non-trained control group.

The data obtained indicate that regular, several year-long active sport training in pubescence leads to a permanent increase of serum IgA concentration regardless of the type of sport practiced. Swimming was the only exception in our study, but even here no values were found to be lower than those of the control group.

Unlike IgA, serum concentration of IgM in pubescent athletes was significantly lower compared to the control group (1.05 ± 0.02 g/l vs. 1.2 ± 0.99 g/l, $p<0.01$) (Fig 1). The analysis of the values of this parameter in subgroups of sports (Table 2) suggests the following inferences: there is no significant difference in this parameter, between the sporsmen practicing track-and-field athletics, weight lifting, sports games and other sports and the control group; swimmers and wrestlers have a significantly lower serum IgM concentratin than that of the control group (by 17.1%, $p<0.05$ and by 14.6%, $p<0.05$, respectively).

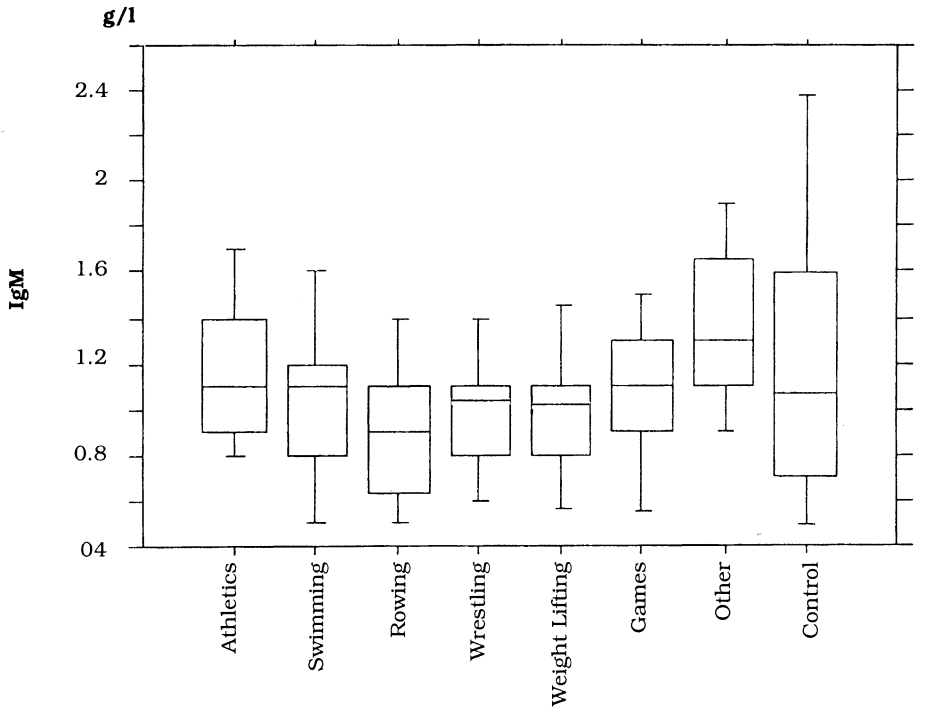

Figure 3. Distribution of the values of serum IgM concentrations in the highly-trained subgroup and in the non-trained control group.

Rowers have the lowest serum IgM concentration (0.96 ± 0.03 g/l), lower by 22.0% than that of the control group ($p<0.001$). In all studied subjects, both athletes and controls, serum IgM concentration was found to be within the range of the reference values for this age group (0.6 - 2.8 g/l) (Fig. 3).

Serum IgG concentration in the athletes was found to be higher than that of the controls (12.37 ± 0.16 g/l vs. 11.06 ± 0.44 g/l) ($p<0.01$) (Fig. 1). There were no differences between the control group and the subgroups of sportsmen practicing wrestling and weight lifting (similar to IgM concentration). All other subgroups showed higher serum concentrations when compared with the controls: rowers by 10.7% ($p<0.05$), swimmers by 15.2% ($p<0.01$), track-and-field athletes by 15.7% ($p<0.05$), athletes practicing sports games by 20.3% ($p<0.001$) and those practicing other sports by 24.9% ($p<0.01$) (Table 2). The distribution of this parameter in the studied subgroups is presented in Fig. 4. In all subgroups IgG were within the reference value range for this age group (8.0 - 18.0 g/l).

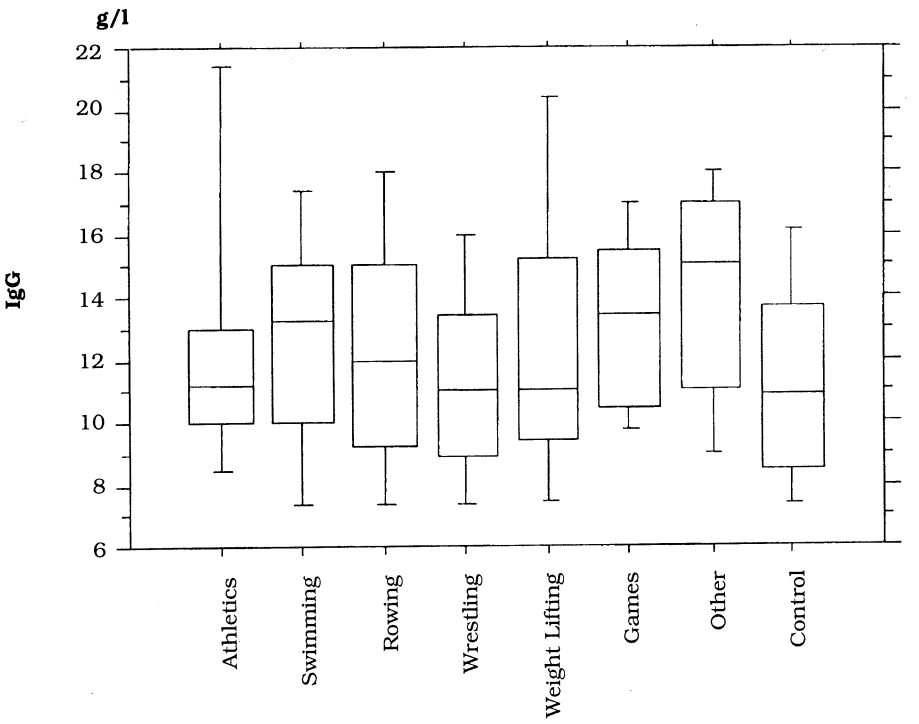

Figure 4. Distribution of the values of serum IgG concentrations in the highly-trained subgroup and in the non-trained control group.

From the results we obtained we draw the following conclusions: 1. Active sports exercise in pubescence can have a long-term influence on the serum immunoglobulin profile. 2. Highly trained pubescent subjects have higher serum IgA and IgG concentrations and lower IgM concentrations than non-trained subjects. 3. The impact of training on serum levels of different subclasses of immunoglobulins varies depending on the type of physical activity characteristic for the specific sport practiced.

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