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Effects of 6 Months of Training Prior to a Major Competition on Hematological and Biochemical Parameters in Young Elite Judoka

[1]Ibrahim Erdemir, [2]Ahmet Sadan Okmen, [3]Yuksel Savucu

[1] Balikesir University, School of Physical Education and Sports, Balıkesir. Turkey
[2]Mugla University, Education Faculty, Mugla. Turkey
[3]Firat University, School of Physical Education and Sports, Elazig. Turkey

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ABSTRACT

This study was conducted in order to examine the effects of 6-month judo training period on maximal aerobic and anaerobic performance, hematological and biochemical parameter responses of eight internationally competitive male judokas. Judokas an average age of 15.5±0.76 years were recruited in this study. The physical measurements including body height, body weight, body-mass index, body fat percentages, cardio-respiratory performance test for measuring maximum oxygen uptake (VO_{2max}) and anaerobic threshold, biochemical parameters and hematological levels of the judokas were analyzed both pre- and post-training season. In order to determine the hematologic and biochemical levels, blood samples (both pre- and post-training), were collected from each participant in gel tubes. The hematologic and biochemical parameters were analyzed in laboratory with using auto-analyzers. The observed increases in the post-training values as compared to the pre-training values for the cardio-respiratory performance tests (i.e., VO_{2max} and anaerobic threshold), the hematological parameters (i.e., basophil %, neutrophil, basophil number, hemoglobin and hematocrit) and the biochemical parameters (i.e., triglyceride and high-density lipoprotein*)* were all significant. The decrease in the post-training values as compared to the pre training values for eosinophil % and eosinophil number were found also significant. A 6-month long-term judo training program improved cardio-respiratory performance and the hematological and changed the biochemical levels of judokas.

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INTRODUCTION

Over the years, an evaluation of the hemogram and plasma or serum biochemistry has been used to assess the health status or function of a range of body systems in elite athletes. In fact many blood tests are commonly used to assess fitness and potential, as well as to investigate poor performance in elite athletes (Kenney *et al*., 2012). Physical and physiological responses also play an important role in hematology and serum biochemistry (Foss *et al*., 2006). When hematological parameters are analyzed, the effects of acute and chronic exercise are reflected in variations in the hematological and biochemical levels (Hohl *et al*., 2012). Indeed, these differences depend on the intensity, volume, and density of training as well as the physical and physiological conditions of the athletes (Koc *et al*., 2012). Moreover, the whole blood and serum or plasma biochemistry can be directly affected by the training level of the athletes (Mougios, 2006).

A longitudinal assessment of the hematologic parameters (Rietjens *et al*., 2002), the cardio-respiratory performance (Kara *et al*., 2010), and the biochemical factors (Patlar *et al*., 2007) may reveal indicators of previously altered situations that could preclude the amplification of a response before the performance is affected. Many studies (Filaire *et al*., 2003; Lazarim *et al*., 2009; Lippi *et al*., 2008; Peake *et al*., 2007) using different types of training methods have already claimed that biomarkers, such as urea, creatinine, and hematological parameters, modulate to some degree with training. Different types of exercises create different degrees of deformation in the muscle, connective tissue, bones, and joints, and may trigger an inflammatory response, thereby promoting repair and muscular regeneration (Powers *et al*., 2011). Therefore, an evaluation of the physical characteristics of athletes is an important part of the training process because it can provide information about variables that should be improved and about the effectiveness of a given training program (Spiropoulos *et al*., 2003).

Corresponding Author: Ibrahim ERDEMIR, Balikesir University, School of Physical Education and Sports, Balikesir / TURKEY.
E-mail: iboerdemir@gmail.com

Therefore this study was designed with the aims of determining to compare the effects of a 6-month training period on the VO_{2max} and anaerobic threshold, the blood hematologic and serum biochemical responses of elite judokas. Additionally Physical and physiological changes of judokas were observed through the training plan.

MATERIAL AND METHODS

Subjects:

Eight healthy, internationally competitive male cadet judokas with an average age of 15.5±0.76 years were recruited for this study. All of the judokas were maintaining their regular training schedule (i.e., 6 days per week and at least 2 training hours per day) throughout the study period. All participants had three years of competitive experience in regional, national, and international tournaments. More specifically, some participants competed at the European Cadet Championships after a 6-month training season. Two of the participants earned a medal in the championship, and four of the participants were ranked in the European Judo Union Cadet Ranking List for the best judokas of the year for 2011.

All of the judokas participating in this study had similar physical characteristics, and all of the tested judokas and their parents were fully informed of the goals and methodology of the study. After receiving the information about the procedures involved, the participants and their parents signed an informed consent agreement that had been previously approved by the local ethics committee. They also agreed to the testing process and the use of their data for further study.

Experimental Design:

The day before testing, the players were not exposed to any high training pressure. Judokas were tested in pre- and post-training in the season. Blood samples were taken in the morning from 9:00 to 10:00am. Four milliliters of blood sample were collected from each participant in gel tubes for every blood test. Blood analysis was determined at the Laboratory at the Faculty of Medicine at Balikesir University. Standard controls were run before each determination. The judoka warmed up for 20 minutes before starting all the physical tests. The physical and physiological tests were determined at School of Physical Education and Sport at Balikesir University.

Physical Tests:

Body height and body weight were measured with an electronic scale (708 Seca, Hamburg, Germany). Body mass index (BMI), body fat % and body fat mass, were measured by the Tanita Body Composition Analyser BC-418, with making use of the bio-impedance electric method.

Cardio-Respiratory Performance Test:

The subjects underwent an incremental treadmill test to estimate their VO_{2max}. Therefore, the Bruce (1972) treadmill test protocol was used and included 7 stages, each lasting 3 minutes, resulting in 21 minutes of exercise for a complete test. All subjects started at stage 1. In stage 1, the subject walked at 1.7 mph (2.7 km) up a 10 % incline. The energy expenditure was estimated to be 4.8 METs (metabolic equivalents) during this stage. The speed and incline increased with each stage. This procedure continued until the subject reached exhaustion. During the test, the gas exchange data (VO_{2max}, ml/kg/min) and heart rate (bpm) of the subjects were recorded at the peak average interval (Fitmate Pro, Cosmed, Italy). Fitmate Pro classified VO_{2max} based on peak VO_2 and anaerobic threshold.

Hematologic Analysis:

The following hematological parameters were assessed: red blood cell (RBC) count, hemoglobin (Hgb) level, hematocrit (Ht), mean red cell volume (MCV), mean cell hemoglobin (MCH), mean cell hemoglobin concentration (MCHC), red cell distribution width (RDW), white blood cell (WBC) count, lymphocyte number (Lym), lymphocyte percentage (Lym %), neutrophil number (Neut), neutrophil percentage (Neut %), monocyte number (Mono), monocyte percentage (Mono %), eosinophil number (Eos), eosinophil percentage (Eos %), basophil number (BASO), basophil percentage (BASO %), blood platelet (PLT) count, platekri (PCT), mean platelet volume (MPV), and platelet distribution width (PDW). These measurements were determined using an automated analyzer (Archem H3000 Hematology Analyzer) according to the manufacturer's instructions.

Biochemical Analysis:

Serum activity for aspartate aminotransferase (*AST*) and alanine aminotransferase (ALT) and serum concentrations of triglycerides, glucose, total cholesterol, urea, creatinine, *high-density lipoproteins (HDL), and low-density lipoproteins (LDL)* were determined using an automated analyzer (Archem BM400 Biochemistry Analyzer) according to the manufacturer's instructions.

Data Analysis:

All data were presented as mean ± standard deviation. A comparison of post training versus pre training values was performed using the Paired-Samples t test in order to examine any differences. The significance level was set at $p<0.05$ and $p<0.01$.

Results:

Changes in demographic and physical characteristic of judokas before and after the long-term training program were listed in Table 1. No statistically significant differences between the pre-training and post-training physical characteristics; body height, body weight, body mass index, body fat and body fat mass of judokas were found.

Table 1: Mean values (±SD) of physical characteristics at pre- and post-training.

Parameters	Pre-training	Post-training	P value
Body Height (cm)	164.75±7.85	164.75±7.85	1.00
Body Weight (kg)	59.04±5.76	60.68±6.98	0.78
Body Mass Index (kg/m^2)	22.33±1.90	22.39±1.50	0.73
Body Fat (%)	18.03±8.15	16.96±9.14	0.62
Bod Fat Mass (kg)	10.72±5.30	10.34±5.70	1.00

The asterisks denote significant differences: *- P <0.05

For the cardiorespiratory performance tests, a significant increase in VO_{2max} ($p<0.02$) was observed between the subjects' average pre-training and post-training results. Meanwhile, a significant increase ($p<0.01$) was observed in the mean anaerobic threshold measured at pre- and post-training (Figure 1)

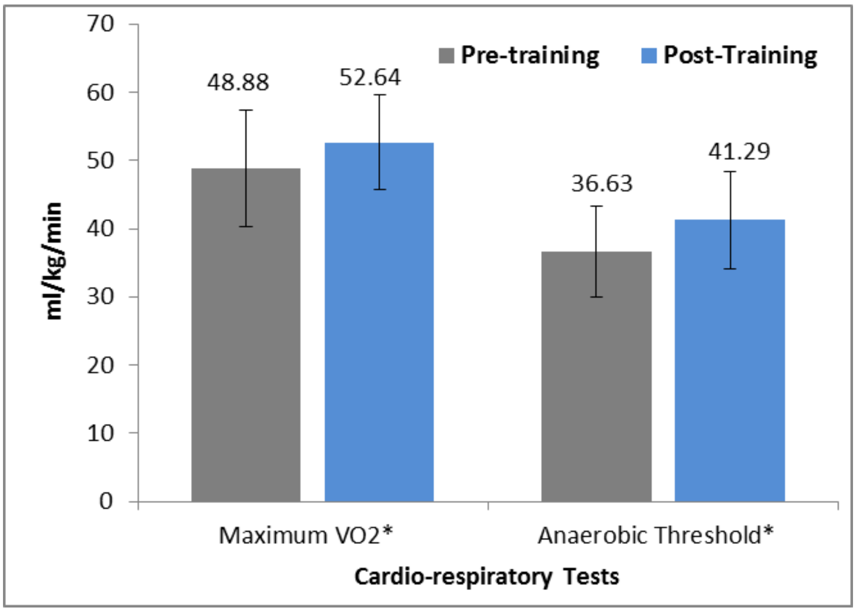

Fig. 1: The differences and mean of Cardio-respiratory Performance Tests.

In terms of the leukocytes and leukocyte subgroups, significant differences were observed in the mean of the BASO % ($p<0.02$), BASO number ($p<0.03$) and Neut ($p<0.04$). Moreover, significant decreases were observed in the mean of Eos % ($p<0.01$) and Eos number $p<0.04$). However, no significant differences were observed in the mean WBC ($p<0.07$), Neut % ($p<0.16$), Lym % ($p<0.09$), Mono % ($p<1.00$), Lym number ($p<0.89$), and Mono ($p<0.08$) (Table 2).

Table 2: Mean values (±SD) of leukocytes, erythrocytes and thrombocyte at pre- and post-training.

Parameters	Pre-training	Post-training	p value
Leukocytes			
WBC (x10^3/µL)	6.08±1.05	7.72±4.06	0.07
Neut (%)	52.05±7.53	58.69±12.10	0.16
Lym (%)	37.30±602	30.89±9.84	0.09
Mono (%)	6.00±0.93	6.25±1.83	1.00
Eos (%)	2.44±1.36	1.56±0.83	0.01*
BASO (%)	0.45±0.25	0.68±0.33	0.02*
Neut (x10^3/µL)	3.19±0.87	4.89±3.96	0.04*
Lym (x10^3/µl)	2.26±0.47	2.12±0.53	0.89
Mono (x10^3/µl)	0.36±0.03	0.44±0.13	0.08

Eos ($x10^3$/µl)	0.14±0.06	0.10±0.05	0.04*
BASO ($x10^3$/µl)	0.02±0.02	0.04±0.02	0.03*
Erythrocytes			
RBC ($x10^6$/µl)	4.74±0.36	4.88±0.41	0.16
Ht (%)	36.98±2.69	38.60±3.41	0.04*
Hgb (G/Dl)	12.46±1.06	13.09±1.46	0.03*
MCV (Fl)	72.38±18.51	79.54±8.39	0.48
MCH (Pg)	26.53±3.38	26.96±3.27	0.61
MCHC (G/Dl)	32.84±2.14	33.84±1.14	0.40
RDW (%)	13.21±0.91	13.24±1.41	0.89
Thrombocyte			
PLT ($X10^3$/µl)	263.25±79.94	244.50±56.18	0.12
PCT (%)	0.21±0.06	0.19±0.05	0.09
MPV (Fl)	8.11±0.58	7.75±0.76	0.45
PDV (%)	44.50±13.47	44.24±16.28	0.78

The asterisks denote significant differences: * p < 0.05

In the erythrocytes and erythrocyte subgroups, significant differences were observed in the mean Hgb (p<0.03) and Ht % (p<0.04) when comparing the pre- and post-training levels. However, no significant differences were found in the mean RBC (p<0.16), MCV (p<0.48), MCH (p<0.61), MCHC (p<0.40), and RDW % (p<0.89) when comparing the pre- and post-training assessments of judokas (Table 2). Additionally, no significant differences were observed in the mean PLT (p<0.12), MPV (p<0.45), PCT % (p<0.09), and PDW % (p<0.78) when comparing the pre- and post-training thrombocyte parameters of judokas (Table 2).

Table 3: Mean values (±SD) of *biochemical* analysis at pre- and post-training.

Parameters	Pre-training	Post-training	p value
Glucose (mg/dl)	85.13±8.89	87.83±5.73	0.53
Urea (mg/dl)	24.38±6.37	30.50±12.73	0.42
Creatinine (mg/dl)	0.70±0.13	0.68±0.14	0.40
Aspartate Aminotransferase (U/L)	23.38±3.81	20.88±5.33	0.36
Alanine Aminotransferase (U/L)	13.38±3.54	14.38±5.85	0.50
Total Cholesterol (mg/dl)	156.13±20.95	167.20±21.32	0.48
Triglyceride (mg/dl)	75.25±30.15	118.00±54.61	0.04*
High-Density Lipoprotein (mg/dl)	48.00±8.68	64.00±15.33	0.03*
Low-Density Lipoprotein (mg/dl)	93.00±13.73	77.20±16.19	0.07

The asterisks denote significant differences: *- P <0.05

Table 3 presents the results of the biochemical analyses for the judokas, and significant differences were observed in the mean levels of triglycerides (p<0.04) and HDL (p<0.03). However, no significant differences were found in the mean levels of glucose (p<0.53), urea (p<0.42), creatinine (p<0.40), AST (p<0.36), ALT (p<0.50), total cholesterol (p<0.48), and LDL (p<0.07) when comparing the pre- and post-training assessment of judokas (Table 3).

Discussion:

This study was conducted to assess the influence of a long-term training program on the VO_{2max}, the anaerobic threshold, and the hematological and biochemical parameters of elite judokas. Some fluctuations (i.e., increases or decreases) were observed in the pre- and post-training values from the cardiorespiratory performance tests and the hematological (i.e., leukocytes, erythrocytes and platelets) and biochemical parameters.

The pre- to post-training changes in the mean levels of certain leucocyte parameters (i.e., the BASO number, the Eos number, the Neut number, the BASO %, and the Eos %) were significant. Additionally, the pre- to post-training changes in the mean levels of certain erythrocyte parameters (i.e., the Hgb and the Ht) were also significant. These results both showed both similarities and differences as compared to those from other studies.

Unal (1998) reported a significant increase in Hgb values for subjects after 8-week of an aerobic exercises. Ohtani *et al*. (2001) studied the amino acid supplementation effects on hematological parameters in elite rugby players and noted significant increases in Hgb and Ht. Moreover, Patlar and Keskin (2007) stated that sub-maximal exercise had a significant impact on Hgb and Ht levels. Meyer and Meister (2011) examined the blood parameters of elite soccer players and found significant differences in Ht during the season. Additionally, Arslan *et al*. (1992) stated that the Ht and RBC count values in elite athletes were higher than that of the control group. We observed an increase in Hgb, Ht, and BASO number after a 6-month judo training period in this study. However, some studies observed a decrease and no changes in Hgb, Ht, and BASO number (Arslan *et al*., 1992). In a study with taekwondo athletes, Cakmakci (2009) found no significant differences in the Ht parameters in blood samples taken before and after a concentrated training period. Moreover, Varol and Taskıran (1995) found that the pre-season RBC levels of handball players were significantly different from their

RBC levels at the end of the season, but no significant difference was observed in the other parameters. Additionally, Kara *et al*. (2010) found no statistically significant difference in Hgb and Ht in elite athletes in their study.

The results of this study indicated that the pre- to post-training changes in certain leucocyte parameters (i.e., WBC, Lym, Mono, Neut %, and Mono %) were not significant, and no significant differences were observed in the following erythrocyte parameters: RBC, MCV, MCH, MCHC, and RDW %. Other studies have reported similar findings for the changes in these parameters. Kara *et al*. (2010) noted that that no significant difference was found in WBC values for the elite athletes in their study. In contrast, Gonzalo-Calvo *et al*. (2012) showed that long-term training was associated with lower levels of WBC. In their study of 11 Olympic athletes, Rietjens *et al*. (2002) analyzed the blood samples of the subjects before and after their training season and determined found no significant change in the MCHC levels. Moreover, Cakmakci (2009) found no significant difference in the WBC counts, RBC counts and platelet counts in blood samples taken before and after a taekwondo camp. On the contrary, Varol and Taskıran (1995) found no significant difference in other hematologic parameters except RBC count for pre-season and post-season blood samples from handball players. However, Magazanik *et al*. (1988) and Varol and Taskıran (1995) investigated the chronic effects of exercise and found a decrease in RBC count after an extended exercise regime. Additionally, Gonzalo-Calvo *et al*. (2012) studied the changes in several emergent geriatric biomarkers in elderly men who had undergone long-term training in order to analyze the effects of long-term exercise on an aged population; they reported that long-term training was associated with lower WBC counts. Ricci *et al*. (1988) found that hematological parameters decreased after chronic exercise. Ercan *et al*. (1996) stated that the RBC and WBC counts significantly increased after long-term training for endurance runing. Additionally, in an investigation involving acute 4-week submaximal exercise, Patlar (2010) noted that both acute and 4-week submaximal exercise have significant effects on leukocytes and leukocyte subgroups.

In the present study, no pre- to post-training changes were observed in the thrombocyte parameters (i.e., PLT, PCT %, MPV, and PDW %). The findings in the literature concerning the changes in thrombocyte parameters due to exercise are mixed. Mannucci *et al*. (1988) and Patlar and Keskin (2007) reported that short-term exercises with lower intensity did not result in any change in blood PLT levels whereas long-term exercises with higher intensity increased the blood PLT level). Moreover, Gonzalo-Calvo *et al*. (2012) showed that long-term training was associated with lower levels of Neut counts. Yet, Kara *et al*. (2010) found no statistically significant differences in the blood PLT values of elite athletes from two different branches.

Regarding biochemical parameters, the t*riglyceride* and HDL levels increased significantly after long-term judo training, whereas the glucose, urea, creatinine, ALT, AST, total cholesterol, and LDL levels did not significantly change after the long-term judo training. Conversely, Filaire *et al*. (2003) researched the effects of a 16-week training period for a major competition on the biochemical parameters in elite gymnast; they noted significant increases in creatinine levels and significant decreases in triglyceride values (2003). Moreover, Ohtani *et al*. (2002) studied the effects of amino acid supplementation on biochemical parameters in elite rugby players and found significant increases in total cholesterol and LDL levels. Additionally, Meyer and Meister (2011) studied these parameters in elite soccer players and found significant changes in the creatinine, AST, and urea levels during the season.

Conclusion:

Ht and Hgb could change the intensity, volume and density of exercise and Ht and Hgb also change the type (aerobic, anaerobic and sprint) of exercise (Baltaci *et al*., 1998; Drygas, 1988; Meyer and Meister, 2011; Patlar and Keskin, 2007; Unal, 1998). Number of studies (Koc *et al*., 2012; Spiropoulos and Trakada, 2003; Unal, 1998) in the literature examined about the effect of acute exercise and noted that Hgb and Ht decreased before and after exercise. The results from this study indicated that maximal and submaximal long-term training increases the level of Hgb and Ht, thereby improving the VO_{2max} and anaerobic threshold of judokas through long-term training. Moreover, we noted relationships between Hgb, Ht, and cardiorespiratory performance in long-term judo training. This could be the result of biological adaptation. It means that judokas did physical exercise regularly and long-term and their metabolism adapted the acute changes physically and physiologically. The physical exercise was repeated regularly for a long time by judokas, chronic changes in metabolism occurred in their blood and cardio-respiratory capacity. Therefore, cardio-respiratory performance increased in long-term judo training because of the biological and physiological adaptation. Additionally, some hematological and biochemical parameters also increased (i.e., Hgb, Ht, HDL, and triglyceride levels) or decreased (i.e., number of Eos and Eos %) in judokas after long-term judo training.

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