

**Review article**

**THE INFLUENCE OF PHYSIOLOGICAL CHARACTERISTICS  
ON THE COMPETITIVE SUCCESS OF JUDO ATHLETES**

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**Abstract.** *The strong connection between physiological adaptations to training and the level of technical abilities of competitors is often difficult to establish since judo is a sport in which technique is dominant, while the physiological characteristics and their parameters make up the basis on which the judo athlete builds his individual technique and tactics. The aim of the paper is to present the results of our own research carried out over the past decade and to indicate the possible guidelines for designing an effective training plan and program. Anaerobic capacity enables an intensive, but short-term manifestation of maximum muscle strength characteristic for this type of sport. For judo athletes, aerobic capacity is the basis for repetition and extended load during a judo match, and especially during overtime in those cases when the final decision was not made during the usual five-minute match. Top judo athletes are characterized by high values of muscle strength and muscle endurance, especially in the upper body. Ideally, judo athletes should, through an optimum combination of training and a proper diet, maintain the percentage of body fat from 7–10%, with the exception of the highest weight categories.*

**Key words:** judo, training, physiological characteristics, adaptation.

INTRODUCTION

Competitive success in combat sports which originate from ancient skills such as judo, depends on several factors among which we also find physiological characteristics. The existence of significant correlations between physiological characteristics and technical elements in judo means that through the improvement of certain physiological variables we can achieve a positive effect on performance during a match. Perhaps the most illustrative example of this is the increase in anaerobic capacity with a decrease in

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the percentage of body fat which enables the performance of a greater number of attacks during a match, while an improvement of aerobic capacity enables quicker recovery between matches. Nevertheless, the strong link believed to exist between physiological adaptations to training, the quality and quantity of training and the level of technical abilities of the competitors is very difficult to determine, since judo is a sport in which technique is predominant, and the physiological characteristics and their parameters are only the basis on which the judo athlete builds his technique and tactics. The aim of this paper is to present the results of our own research carried out over the past decade and indicate any possible guidelines in designing effective training plans and programs.

## MAIN TEXT

### **Bioenergetic capacity**

The general conclusion of the research carried out to date is that the physiological profile of judo athletes, as an interconnection between aerobic and anaerobic metabolism, cannot be defined precisely. The aforementioned conclusion can partially be explained by the fact that all judo athletes are divided into weight categories, which creates a differences in body weight and body composition, and partially individual techniques and tactical skills, which as a unit influences the physiological profile of these athletes. Both parts of the bioenergetic capacity, the anaerobic and aerobic one, are active during the match. Anaerobic capacity enables an intensive, but short-term manifestation of maximum muscle strength characteristic for this type of sport. Aerobic capacity for judo athletes is the basis for repetition and extended load during a match, especially during overtime in the case when a final decision has not been made during the usual five-minute judo match (International Judo Federation Referee Rules, 2003).

As is widely known, the basic characteristic of judo is variability, in the sense of changes in the intensity of the load and breaks during a match. These temporal characteristics of the match have very significant physiological influences, considering that short periods of high intensity load, with even shorter rest periods result in a high percentage of the participation of lactate anaerobic metabolism at the beginning of the match, as well as during some of its parts. Judo athletes often compete in several matches during just one day, and sometimes even with short time intervals between them. That is why it is quite possible that if the accumulation of lactate is the cause of muscle fatigue, a judo athlete who is capable of extracting lactates faster begins the following match with a smaller propensity towards fatigue and thus stands a better chance of achieving better competitive results. Thus, for top competitive results, a judo athlete needs to be in possession of the appropriate lactate anaerobic and aerobic energy systems for maintaining competitive skills during the entire duration of the match. The development of both parts of the bioenergetic capacity should be one of the main goals during the preliminary period, and its composition and duration (through individual training sessions and in the form of overall load) should enable the achievement of optimal physiological adaptations.

On the basis of the results of the research carried out over a six-week preliminary period prior to the national championship, which have indicated statistically significant higher numeric values of anaerobic capacity (the relative values of average strength) and maximum oxygen uptake, with a decrease in body weight and percentage of body fat, the authors drew the conclusion that changes in the training plan and program preceding the

competition can result in more significant changes even among competitors who had been involved in the training process for several years (Radovanovic, Bratic, Nurkic, & Vukajlovic, 2005).

The significance of functional variables for achieving competitive success was studied on a sample of elite judo athletes (Bratić, Radovanović, Nurkić & Kafentarakis, 2008). The research was carried out during the final stages of the preliminary period for the European Cadet Championship, and the results have indicated that the competitors who achieve better results are usually characterized by greater upper body strength and greater aerobic endurance.

With the aim of obtaining more quantitative indicators of physiological adaptations to physical requirements during years of specific training, eight of the elite judo athletes of Serbia were tested during the preliminary period for the European Championship (Radovanović, Bratić & Nurkić, 2009). The battery of tests consisted of determining the parameters of anaerobic capacity by means of the Wingate test, the evaluation of maximum oxygen uptake following a submaximum test on a hand and foot bicycle-ergometer and measuring of the parameters of forced expiration prior and following the load test. The authors have suggested the aforementioned battery of tests for the evaluation of the functional status of young judo athletes, which was also used in the research that stemmed from this one.

Research with the aim of determining the relationship between the manifest strength during short-term load of maximum intensity and the reduction of forced lung parameters was carried out on a sample of 11 elite judo athletes (Radovanovic, Bratic, Nurkic, & Stankovic, 2011). Forced vital capacity (FVC) and forced expiratory volume during the first second ( $FEV_1$ ) were determined prior and following a 30sec maximum test on a bicycle-ergometer. The analysis has determined that the correlation is positive (the participants who scored higher values on the parameters prior to, also had higher values after the test) and is statistically significant. In addition, for FVC and  $FEV_1$  it has been determined that the strength of the correlation is lowest immediately following the test, and then that it increases over time when recovery of the lung function occurs. These results have shown that in the case of elite judo athletes the strength manifested during short-term load does not have a negative influence on the recovery process between two attacks.

### **Muscle force and strength**

A high level of muscle force and strength, along with good muscle endurance for fatigue tolerance are necessary preconditions for competitive success considering the fact that judo is characterized by alternations between activities of maximum intensity with an average duration of 15–30s and breaks of an average duration of approximately 10s (Sterkowich, & Emerson, 2000). Elite judo athletes are characterized by high values of muscle strength and endurance, especially in the upper body (Franchini, Takito, Kiss et al. 2005; Blais, Trilles & Lacouture, 2007). This is a direct indication that physical fitness should be focused on the improvement of the muscle parameters of the upper body. Even though the cited characteristics have been identified in several different studies involving elite judo athletes, and as such could be considered the ideal profile to which we should aspire during the preliminary period, a lot less is known of the differences between ideal profiles in various weight categories. In addition, research has been carried out and has indicated that the values of muscle strength are more pronounced in the lower body (Franchini, Del Vecchio, Matsushigue & Artioli, 2011).

In a study which included 20 young highly selected judo athletes, the evaluation of muscle strength and muscle endurance was carried out through a combination of laboratory and field tests. The testing was realized at the beginning of the preliminary period and after a period of ten weeks, at the end of the preliminary period. On the basis of the obtained results, we have concluded that the proper periodization of strength training, as a part of the preliminary training program, enables the adequate physiological adaptation of judo athletes which results in an increase in muscle strength with the preservation of muscle endurance (Bratić, Radovanović, & Nurkić, 2008).

Applied on a sample of elite young judo athletes, a discriminant function has shown that there is a significant difference, at the multivariate level, between the results from the beginning and end of the preliminary period. The discriminant function was best described by the following tests: the relative value of average strength, the relative value of the greatest value of strength and the relative value of oxygen uptake, which has indicated that the preliminary period had a positive effect on the improvement of the functional abilities of elite young judo athletes (Nurkić, Bratić, Radovanović, & Bojić, 2009).

Due to the previously mentioned changes in the human body that take place during judo matches, judo athletes are often subjected to concurrent training for the development of muscle force and the development of aerobic (cardiorespiratory) endurance with the aim of achieving adaptations specific for both types of training. However, the question of how compatible these two types of training are when performed simultaneously remains open if we take into consideration that their application has as a result different physiological adaptations. For that reason, during the 12-week concurrent training for the increase of strength and cardiorespiratory endurance, the change to the parameters of oxidative stress were also monitored on a sample of 14 judo athletes, divided into an experimental and control group. In addition, we also compared the effects of such a training program with those of a usual training program of judo athletes on maximum oxygen uptake, parameters of anaerobic capacity, situational-motor skills and body composition. The obtained results have indicated that the concurrent strength training and endurance training led to an increase in maximum oxygen uptake and anaerobic capacity but also caused a disbalance between reactive oxygen species and the antioxidative system in the body. The paper reviews the possibility that the creation of pro-oxidants represents a stimulus for the increase of antioxidant defense with the aim of achieving optimal physiological adaptation to this type of training.

The following research in which the participants were involved in a short concurrent training program (which lasted over a period of four weeks) and with smaller load during strength training, has shown that this sort of preliminary pre-season preparation need not be accompanied by negative effects manifested through the increase in the parameters of oxidative stress. However, we must point out that the weight of the participants in this study was in accordance with their competitive category, that is, that in the aforementioned preseason training program the participants had not be subjected to a significant reduction in body weight.

### **Percentage of body fat**

The somatotype of elite judo athletes is characterized by pronounced mezomorphic features (pronounced muscular features and proper proportion accompanied by a low percentage of body fat). Ideally speaking, judo athletes should, through an optimum combina-

tion of training and a proper diet, maintain a percentage of body fat from 7–10% (Franchini, Del Vecchio, Matsushigue & Artioli, 2011), with the exception of the greatest weight categories (up to 100 kg and over 100 kg). Research has shown that elite judo athletes (those who have won Olympic and World Championship medals) have less than 10% body fat (Sbriccoli, Bazzucchi, Di Mario et al., 2007; Franchini, Nunes, Moraes et al., 2007).

In the research carried out on a sample of 11 experienced judo athletes (those who have won medals at state and Balkan championships) who compete in lower weight categories it has been concluded that the aforementioned low values of the percentage of body fat characterize the most successful competitors (Radovanović, Nurkić & Radovanović, 2006).

With the aim of studying the effects of a two-week supplement intake of creatine monohydrate and a specially designed training program on the anaerobic capacity and body composition of judo athletes, the research protocol used consisted of a laboratory Wingate test on a bicycle ergometer for the upper extremities, an evaluation of body composition and a field-specific judo fitness test (Radovanović, Bratić & Milovanović, 2008). The obtained results have indicated that a two-week process of supplement use involving creatine monohydrate and a specially designed training program, although shorter than the ones described in existing literature, do have a significant effect on anaerobic capacity and body composition of judo athletes.

On the basis of the published results of focused scientific research and year-long experience, with the aim of the appropriate preparation of the elite judo athletes of Serbia, strategies for the regulation of body weight and the decrease of body fat have been designed (Radovanović & Todorov, 2011). Through the objective determination of individual aims in the appropriate period (basic–preliminary, specific–preliminary, competitive and off-season) the guidelines and procedures for body weight regulation and/or reduction of body fat have been determined and incorporated into specific training content for the appropriate period. One of the aims of the mentioned strategies is the avoidance of extreme short-term approaches for the reduction of body weight which have a negative impact on competitive success.

## CONCLUSION

The extent of the influence of the physiological characteristics of judo athletes and their competitive skills during a match has still not been explained and has not been fully investigated, and thus requires further research. Future studies could be designed so that the measuring or evaluation of physiological characteristics will be combined with a detailed match analysis, in the attempt to establish an even stronger relationship between physiological and technical characteristics in judo. In addition, it is necessary to further develop judo-specific tests and carry out longitudinal studies so as to design optimum profiles in relation to a particular weight category. This could facilitate the more precise definition of the guidelines for planning and programming general and specific training programs.

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## UTICAJ FIZIOLOŠKIH KARAKTERISTIKA NA TAKMIČARSKU USPEŠNOST DŽUDISTA

*Čvrstu vezu između fizioloških adaptacija na trening i nivoa tehničkih sposobnosti takmičara je veoma teško uspostaviti jer je džudo sport u kojem preovlađuje tehnika, dok su fiziološke karakteristike i njihovi parametri samo osnova na kojoj džudista bazira individualnu tehniku i taktiku. Cilj rada je da prikaže rezultate sopstvenih istraživanja sprovedenih tokom protekle decenije i ukaže na moguće smernice pri osmišljavanju efektivnog plana i programa treninga. Anaerobni kapacitet omogućava intenzivno, ali kratkotrajno ispoljavanje maksimalne mišićne snage karakteristične za ovu vrstu sporta. Aerobni kapacitet je džudistima osnova za ponavljane i produžene napore tokom trajanja borbe, a naročito tokom produžetka u slučaju da konačna odluka nije doneta na kraju uobičajenog petominutnog trajanja meča. Vrhunske džudiste karakterišu visoke vrednosti mišićne snage i mišićne izdržljivosti, naročito u gornjem delu tela. U idealnom slučaju, džudisti bi trebalo da optimalnom kombinacijom treninga i pravilne ishrane održavaju procenat masnog tkiva od 7–10%, sa izuzetkom najvećih težinskih kategorija.*

Ključne reči: džudo, trening, fiziološke karakteristike, adaptacija.