Oxidative stress in young judokas: Effects of four week pre-competition training period

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Source of support: This study was partially supported by grant number 41018 III from the Ministry of Science and Technological Development of the Republic of Serbia

Received: 21 April 2012; **Accepted:** 17 August 2012; **Published online:** 21 August 2012

Abstract

Background and Study Aim: The effects of long-term exercise on steady-state dynamics of antioxidant defence system are not clear yet fully, and there is an evident lack of studies focused on combat sports. This study aimed to evaluate the parameters of oxidative stress in young judokas during four weeks pre-competition training period.

Material/Methods: Changes of oxidative stress parameters (malondialdehyde, catalase, carbonyl and sulphydryl groups, and total antioxidant status) were studied during four week pre-competition training period on a sample consisting of 10 male judokas (age 20±1.3 years, sport experience 11±3.4 years).

Results: The changes in all examined oxidative stress parameters showed no statistical significance. Results also suggested that well-developed anti-oxidant defence, particularly because of the superoxide dismutase activity, kept the amount of oxidized proteins unmodified. The explanation for this finding can be found in the facts that the subjects, although of young age, had a long training and competitive experience with the similar training programs and that they did not undergo rapid weight reduction.

Conclusions: The obtained results suggest that four week pre-competition training period pattern had no effects on oxidative stress parameters in well-trained young judokas, and that natural antioxidant defences of the body responded adequately to complex training program.

Key words: oxidative stress • judo • antioxidant defence • training

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Background

Oxidative stress – represents an imbalance between the production of oxidative species and the capability of antioxidant defences.

Antioxidant defence – cellular systems which can terminate chemical chain reactions by removing free radical intermediates, and inhibit other oxidation reactions.

Oxidative stress represents an imbalance between the production and manifestation of reactive oxygen species (ROS) and a biological system's ability to readily detoxify the reactive intermediates or to repair the resulting damage. Disturbances in the normal oxidation-reduction (redox) state of tissues can cause toxic effects via the production of peroxides and free radicals that damage all components of the cell, including proteins, lipids, and DNA [1]. Oxidative stress is associated with increased production of oxidative species or a significant decrease in the capability of **antioxidant defences**. The elevated metabolic rate associated with acute strenuous exercise and chronic exercise training leads to increased mitochondrial oxygen consumption in tissues, free radical generation, metabolite oxidation and antioxidant depletion [2,3]. The main sources of ROS during exercise are the mitochondrial respiratory chain, xanthine oxidase-catalysed reactions and neutrophil activation [4]. The markers of oxidative stress and oxidative status might be important parameters in biological follow-up of athletes.

Table 1. A draft of a four-week pre-competition training program.

Days/weeks	4 weeks before competition	3 weeks before competition	2 weeks before competition	1 week before competition
	Number of training sessions/durations of one training sessions (hours)			
Monday	2/1.5–2 h	2/1.5–2 h	2/2 h	1/1.5 h
Tuesday	2/1.5–2 h	1/1.5–2 h	2/2 h	2/1.5 h
Wednesday	1/1.5–2 h	2/1.5–2 h	1/2 h	Active recovery
Thursday	2/1.5–2 h	2/1.5–2 h	Active recovery	1/1.5 h
Friday	2/1.5–2 h	Active recovery	2/2 h	2/1.5 h
Saturday	Active recovery	2/1.5–2 h	2/2 h	1/1.5 h
Sunday	2/1.5–2 h	2/1.5–2 h	2/2 h	2/1.5 h
Total	**11/16.5–22 h**	**11/16.5–22 h**	**11/22 h**	**9/13.5 h**

Numerous studies have investigated the effects of exercise or estimates of physical activity on oxidative stress in athletes [5–10]. However, it is difficult to predict the effect of different training regimes and bioenergetics requirements on oxidative status because of different mechanisms of free radical generation. The risk of oxidative stress with exercise depends on the exercise intensity and the participant's state of training [11]. It is widely assumed that oxidative stress is detrimental to exercise performance, but there is little experimental evidence to support this [12].

Prolonged periods of intense training and/or intense competition are associated with a large variety of hormonal, immunological, haematological and biochemical changes [13]. Oxidative stress markers could be of interest, in addition to other physiological variables, because of possible links between oxidative stress and overtraining. Previous studies suggest that an accumulation of intense exercise (intense period of training and/or competition) can provoke an increase in oxidative stress [14]. This can be the origin of muscular fatigue and injuries. If the individual recovery capacity is overreached, these changes can contribute to the appearance of overtraining, which in turn may aggravate the oxidative stress [15]. However, there is no evidence that this affects sporting performance in the short term, although it may have longer term, not necessarily detrimental, health consequences. The effects of long-term exercise on steady-state dynamics of antioxidant defence system are not clear yet fully, and there is an evident lack of studies focused on combat sports.

Judo – literally meaning "the way of softness and flexibility", judo is a complex sport where many variables (technical, tactical, physiological, and psychological) determine the final result.

Training effect – physiological adaptation to repeated bouts of exercise.

This study aimed to evaluate the parameters of oxidative stress in young judokas during a four weeks' pre-competition training period.

Material and Methods

A total number of 10 male judokas (age 20±1.3 years, sport experience 11±3.4 years) participated in the investigation. All of the subjects were presented with the relevant information in written form regarding the aims, course, participation, and possible adverse side effects of the study and all of them voluntarily gave written consent to participate in the present study. The study did not enrol the competitors whose body weight had been over 5% higher than the weight category in which they competed. Four weeks prior to blood sampling the participants were instructed to abstain from any vitamin or anti-oxidant dietary supplementation. None of the participants reported any eating disorders, had no on-going or previous (last half-year) injuries, they were not on any medication known to affect oxidative stress and were non-smokers. A limitation to our study was the absence of a nutrient intake control since we were unable to exactly monitor athletes' diet.

The study was conducted during the preparation period for National team Championship. Four week pre-competition training period consisted of strength training (with loading 45–55% of 1RM, repeat cycles 16–20 times in 4–5 series), aerobic training (running), exercises with specific sport equipment (rubber bands, horizontal ladders, fitness ball, the Swedish bench) and **judo** fights (randori). Within the four-week training activities, the judokas overall had 42 training sessions, 11 during the first, second and third week each and 9 during the fourth week of training. The duration of the training sessions during the first and second week ranged from 1.5 to 2 hours, 2 hours during the third week and 1.5 hours during the fourth (last) week. The overall time of the training activities during the first and second week ranged from 16.5 to 22 hours, up to 22 hours during the third week and up to 13.5 hours during the fourth week (Table 1). The basic structure of the training with the type of load was the following: aerobic load – 30%, alactate-anaerobic load – 20%, lactate-anaerobic load – 10%, and mixed load – 40%. The initial rhythm of increase and decrease had a ratio of 4:1 during first three

Table 2. Subjects physical characteristics during a 4-week pre-competition training period (n=10).

Variables (unit)	Initial	Final
Age (years)	20±1.3	
Sports experience (years)	11±3.4	
Body height (cm)	174.5±7.2	
Body weight (kg)	73.1±9.4	70.6±8.1*
Body fat content (%)	8.9±4.1	7.3±2.9*

Values are means ±SD. * Significant difference (p<0.05) from corresponding initial value.

Table 3. Parameters of oxidative stress biomarkers in the study period.

Oxidative stress parameter (unit)		Min–max	Me (25.–75. percentile)
Erythrocyte MDA ($\mu mol \cdot L^{-1}$)	Initial	9.33–19.29	13.84 (10.69–16.81)
	Final	10.13–45.74	15.62 (15.17–27.21)
Plasma CAT ($IU \cdot L^{-1}$)	Initial	1.82–15.29	7.21 (4.08–14.72)
	Final	6.91–51.32	9.44 (10.38–44.20)
Sulphydryl group ($\mu mol \cdot L^{-1}$)	Initial	148.01–280.65	191.06 (153.8–258.01)
	Final	118.74–363.52	205.73 (135.97–253.64)
Carbonyl group ($\mu mol \cdot g^{-1}$)	Initial	0.38–1.73	0.59 (0.47–1.18)
	Final	0.35–2.25	0.70 (0.55–1.11)
Total antioxidant status (%)	Initial	44.10–97.10	84.55 (47.08–94.53)
	Final	28.00–95.60	78.67 (43.80–86.43)

Values are Me (25.–75. percentile). * Wilcoxon test: significant difference (p<0.05) from corresponding initial value.

weeks, and 3:1 during the last week, which means a 3 to 4 time increase in the training sessions and 1 easier training session, except for small corrections during the third week. By using various combinations we achieved the required diversity, while strictly taking into account the adaptation skills of judokas to focus further in the desired direction.

The investigation protocol consisted of anthropometric measurements (weight, height, body fat) and blood sampling. Initial measurement and blood sampling were carried out at the start of the described training period, while the final measurements and blood sampling was conducted after the completion of all training. Body height was measured by means of an anthropometer (GPM, Switzerland) and the results of the measurements were accurate within 0.1 cm. Body weight was measured by means of electronic scales (Tefal, France) with an accuracy within 0.1 kg. The body fat content was estimated by bioelectrical impedance analysis method and the device BF300 (Omron, Japan) was used. Data regarding percentage of fatty tissue were read off the display with an accuracy of 0.1%. Venous blood was collected into evacuated tubes (Vacutainer, Becton Dickinson, USA) from the antecubital vein with minimal stasis. Blood samples were transported and stored in the laboratory where analyses were performed strictly following international guidelines [16]. The following parameters were measured in plasma: malondialdehyde (MDA), catalase (CAT), carbonyl and sulphydryl groups assay for determination of modified proteins and total antioxidant status (TAS). Blood markers of oxidative stress were determined by standardized spectrophotometry techniques [17–19].

Statistical analysis

Depending on a statistical marker, measurement scale, type of distribution, and number and size of samples, the following tests were used: Student's t-test, Mann-Whitney U test, the Wilcoxon rank sum test, and the Wilcoxon test for paired samples. In order to process the results of the study, the SPSS statistical program for Windows (Release 13.0, Chicago, IL, USA) was used. Statistical significance was set at p=0.05 for all statistical analyses.

Results

The results of study were presented in Tables 2 and 3. Obtained results in Table 2 shown statistical significance reduction of body weight and body fat content during a 4-week pre-competition training period. The changes in all examined oxidative stress parameters (Table 3) showed no statistical significance.

Discussion

Judo combat is characterized by complex motor skills of short duration and high intensity that are performed intermittently [20,21] and require energy to be supplied by both anaerobic and aerobic metabolisms [20]. One of the goals of training periodization therefore is to enhance the capacity of both aerobic and anaerobic metabolism to allow judo athletes to maintain optimal performance for the entire combat duration. Increased production of free radicals does not necessarily have a negative impact on athletes' health, considering that the consequences of oxidative stress include adaptation mechanism by upregulation of antioxidative defence system [7]. Oxidative stress in anaerobic exercise is accompanied with ischaemic reperfusion of muscles and xanthine oxidase activity in addition to electron leakage that happens during aerobic training regime [1]. Also, it has been shown that an anaerobic training regime has a positive effect on oxidative status and lower muscular damage was observed compared with aerobic regimes [22,23]. Considering mixed training, studies showed significant improvement in enzymatic antioxidant defence system but higher training and competitive load can induce excessive free radical production [5].

The training program must be sufficiently long and intense to trigger a consequent adaptive response of the antioxidant system and decrease of oxidative stress [1]. The most important finding in this study was the lack of statistical significant differences in all examined oxidative stress parameters during a 4-week pre-competition training period. The explanation for this finding can be found in the fact that the subjects, although of young age, had a three years long experience with the similar pre-competitive preparation programs. Our results also suggested that well-developed anti-oxidant defence, particularly because of the superoxide dismutase activity, kept the amount of oxidized proteins unmodified. One of possible explanations of the obtained results was that all the examinees were previously engaged in a several weeks' basic preparation activity during which period the intensities of strength training and aerobic training were higher than that applied during the pre-competition four-week period of the study. Previous studies suggest that the anaerobic-trained subjects have a better antioxidant enzyme activity in the blood, tissues and especially in working muscles [24–26], but this improvement was not found in every study [23]. According to Cazzola et al. [6] anaerobic practice increase concentrations of non-enzymatic antioxidants as results of repeated free radicals production during ischemia reperfusion and inflammation provoked by this type of exercise at muscular level.

The absence of statistically significant differences in the investigated parameters of oxidative stress can be partly explained with the selection of examinees for the study. Previously published data of an experimental study of the impact of a rapid reduction of food intake on the parameters of oxidative stress [27] prompted us to exclude the judokas whose body weight had been over 5% higher than the weight category in which they competed. Reduction of body weight and body fat content, although of statistical significance, probably occurred gradually during the four weeks of the study and did not trigger the disturbances in the normal redox state of the tissues. Based on the obtained results, we may draw a conclusion that the applied pre-competition training period led to weight reduction without any overcoming of the capability of antioxidant defences. We believe the results, although quite indirectly, suggest the possibility of increasing pre-competition training workload with a lower risk of overtraining syndrome, in judokas with steady body weight related to their competition weight category. Possible shortcomings from the earlier phases of preparation period can thus be corrected.

Conclusions

The mechanisms of exercise-induced oxidative stress are not well understood and they depend on other factors as well, such as mode and intensity of exercise, and site of free radical production. The results obtained suggest that four week pre-competition training period pattern had no statistically significant effects on oxidative stress parameters in well-trained young judokas, and that the body's natural antioxidant defences responded adequately to complex training program. The results, although indirectly, suggest the possibility of increasing pre-competition training workload with a lower risk of overtraining syndrome, in judokas with steady body weight related to their competition weight category.

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