Alteration in biomarkers of oxidative stress in judokas with different age

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Abstract

Increased intensity of physical activity is accompanied by increased consumption of oxygen throughout the body, especially by skeletal muscle. Part of this oxygen, is transform into mitochondria in H_2O, while a smaller part (2-5%) makes a reactive oxygen species, toxic forms of oxygen. The aim of this study was to determine eventual differences in oxidative stress parameters, in judokas different age, after applied training. The sample of this research includes 24 elite judokas, different age, divided into three groups according to age categories. Monitoring the changes in oxidative stress biomarkers was determined by activity of superoxide dismutase (SOD), glutathione reductase (GSH-R), glutathione peroxidase (GSH-Px), catalase (CAT), and total antioxidant capacity (TAS). After applied training SOD, CAT and GSH-Px activity in judokas senior age, increased statistical significantly, in compared with judokas of younger senior age. Also, statistically significance increased was noted in SOD activity in senior age judokas, in relation to junior age judokas. Obtained data of this research has shown that training program and maximal load during training, which require modern judo, cause alteration in some biomarkers of oxidative stress. These changes are expressed in higher level in judokas senior age, which can cause oxidative stress.

Key words: Oxidative stress, judo, physical activity

Introduction

There is a growing body of evidence that the appearance of free radical fulfils important physiological functions in cells, and that a balance between antioxidants and free radicals is necessary for desired physiological adaptations (Gomez-Cabrera et al., 2008, Ji, 2008).

According to the theory of aging which is based on free radicals, in the process of aging, the natural antioxidant capacity of the organism weakness as a result of genetically programmed reduction in the synthesis of antioxidants, or due to reduced absorption of antioxidant vitamins, which also induces the activity of reactive oxygen species and leads to aging. Aging is associated with increased free radical generation in the skeletal muscle that can cause oxidative modification of protein, lipid, and DNA (Radak et al., 1995). Physical activity has many well-established health benefits, but strenuous exercise increases muscle oxygen flux and elicits intracellular events that can lead to increased oxidative injury. Research evidence indicates (Cooper et al., 2002) that senescent organisms are more susceptible to oxidative stress during exercise because of the age-related ultra structural and biochemical changes that facilitate formation of reactive oxygen species (ROS). Free radicals are thought of as perpetrators of cell damage, ageing, even cancer, whereas antioxidants are seen as defense against these threats (Fabel et al., 2003; Gross et al., 2011). Furthermore, in low concentrations free radicals may also have positive effects and help maintain muscle force production (Jackson, 2009). Substances that protect the cells of our body from free radicals are called antioxidants. The capacity of their production is not only determined by genetic and gender (Dopsaj et al., 2011), but also with age and lifestyle of the organism (Voss and Siems, 2006; Veglia et al., 2006). When is the condition of the body is such that there is increased production of free radicals with reducing possibility of their removal and neutralization,

it talks about state of oxidative stress that can lead to pathophysiological changes in the human body (Halliwell and Gutteridge, 1999; Booth and Lees, 2007). Enzymatic antioxidant activity (SOD, CAT and GPX) is quantified in a large majority of studies (Radak et al., 2008). This method can evaluate the quality of antioxidant protection at rest but can also show the importance of oxidative stress, especially after physical activity.

The aim of the present investigation was to examine potential changes in oxidative stress biomarkers after acute training in the three different age groups of highly trained judokas. We hypothesized that acute training would results in oxidative stress biomarkers change, in higher level in athletes of senior age group.

Material and methods

The sample consisted in 24 male judokas divided into three groups according to age categories. There were divided to athletes age, as follows: juniors (group A), younger seniors (group B) and seniors (group C) from Serbian national team. Tested athletes were subjected to a training regime consisting in a minimum 10 hours of work out per week, in the last 4 years. Prior the testing, all subjects were informed about the requirements of the study and gave their consent when accessing the research. All subjects underwent a detailed medical examination during which it was established that all subjects were in excellent health without cardiovascular, respiratory, endocrine or other disorders.

Blood collection and biochemical analysis

Blood samples were taken from the antecubital vein inside of the elbow into plain vacutainer tubes. The site was cleaned with germ-killing medicine (antiseptic). The health care provider wrapped an elastic band around the upper arm to apply pressure to the area and made the vein fill with blood. Blood samples were taken from all subjects in the morning immediately after the training. Serum samples were used to determine the activity of the enzymes: superoxide dismutase (SOD), glutathione reductase (GSH-R), glutathione peroxidase (GSH-Px), catalase (CAT) and total antioxidant activity (TAS).

Study protocol

Prior the testing all participants were given detailed instructions and got familiarized with testing procedure. Maximal oxygen consumption (VO_{2max}) was assessed with the COSMED treadmill (Model T 170). Data were collected with COSMED gas analyzer (CPET). The protocol itself included progressive increments of workload at the rate of 2km/hr every 2 min until exhaustion. The test was considered completed when the respiratory quotient reached the reference values, while the subjective state of each participant was monitored during the protocol.

Statistical analysis

All values are expressed as mean ± standard deviations. The Statistical Package for Social Science (SPSS version 19.0 for Windows) was used for analyses. One-way ANOVA followed by Scheffe's post-hoc test were used to compare mean values in 3 subgroups of judokas.

Results

General characteristics in three groups of judokas with different age are presented in Table 1. The mean VO_{2max} values of each group are also shown in Table 1.

Table 1. Physical characteristics and aerobic capacity in junior, younger senior and senior age group of male judokas

Variable	Group A (N=8)	Group B (N=8)	Group C (N=8)
Age (year)	17.6 ± 0.4	21.9 ± 1.2	26.9 ± 0.9
Body Weight (kg)	68.9 ± 10.1	71.9 ± 5.4	81.6 ± 5.9
Height (cm)	172.5 ± 5.3	173.5 ± 2.1	180.6 ± 5.6
Vo_{2max}/kg	53.1 ± 2.2	56.5 ± 3.1[a c]	50.6 ± 2.5

Values are expressed as mean ± SD.

Table 2. Antioxidant enzyme activity and total antioxidant capacity in judokas with different age groups

Parameter	Group A (N=8)	Group B (N=8)	Group C (N=8)
SOD (U/gHb)	1222 ± 62	1238 ± 43	1295 ± 21 [a b]
CAT (kU/gHb)	325 ± 23	293 ± 46	360 ± 40 [b]
GSH-R (U/gHb)	11.5 ± 0.1	11.0 ± 0.6	11.7 ± 0.2
GSH-Px (U/gHb)	71.2 ± 0.5	70.6 ± 1.2	72.1 ± 1.2 [b]
TAS (mmol/L)	1.30 ± 0.04	1.30 ± 0.03	1.32 ± 0.07

Values are expressed as mean ± SD.

In the present study Vo_{2max} values of male judokas exhibit variation in different age categories, and it has been seen that during adolescence (under 19 years), aerobic capacity is higher in compared with senior age group of judokas, and lower in compared with younger senior age group.

It has been seen (Table 1) that judokas in younger senior age group have had the highest values of Vo_{2max} in compared with A and C group Therefore, the increases in Vo_{2max} ensures higher rate of oxygen supply. It can be stated that body mass increases and Vo_{2max} decreases as the age of the judokas increases.

An important finding, in the results of judokas, is that the activities of primary antioxidant enzymes (SOD, GPX-Px and CAT) increased with age after applied training (Table 2). The antioxidant enzyme activities were similar in both A and B groups. However, the relationships between activities of the examined enzymes were significantly different in compared with C group. After training, the senior age group of judokas had higher values for all antioxidant and oxidative stress markers as compared to the A and B group. The results of primary antioxidant enzymes in senior age group has shown statistically higher values of SOD, CAT and GSX-Px in compared with B group, as well as higher values in SOD activity in compared with group A. However, no statistically significance change in GSH-R and TAS activity was observed between groups. These results indicate that older athletes with lower values of Vo_{2max} respond to oxidative stress by increasing SOD, GPX-Px, and CAT activity.

Discussion

Numerous studies have investigated the antioxidant enzyme activity in the blood or in tissue after both aerobic and anaerobic exercise in judokas (Radovanovic et al., 2009; Trivic et al., 2011), but only few have examined the additional impact of age and acute phase response on oxidative stress state (Martinovic et al., 2009; Mrowicka et al., 2010).

Training can have positive or negative effects on oxidative stress depending on training load, training specificity and the basal level of training. Physical exercise can increase oxidative stress and causes disruptions of the homeostasis (Finaud et al., 2006), so the free radical eliminating capacity is an important factor in adaptation to training and exercise. One response to the elevated oxidative stress associated with exercise is increased oxidant defense via up regulation of powerful antioxidant enzymes like SOD, CAT and GSH-Px.

Results of this research have shown that judokas in senior age group had significantly higher value of these parameters after applied training in compared with junior and younger senior group of judokas. Superoxide dismutase (SOD), along with catalase and glutathione peroxidase, form the front line of the body's antioxidant enzyme defenses. This study demonstrated remarkably higher activities of enzymes (SOD, CAT and GPH-Px) in senior judokas in compared with younger age group of judokas (Table 2), while no difference being found for GSH-R and plasma TAS. Physical exercise seemed to increase accumulation of free radicals as a response to the increased oxygen utilization (Carmeli et al., 2000). Elevated metabolic rates as a result of exercise may dramatically increase oxygen consumption (VO_{2max}). Importance of aerobic power to judo performance is controversial. While some authors (Franchini et al., 2005) did not found significant differences in VO_{2max} between elite and non-elite judo players, some results (Muramatsu et al., 1994) indicate that aerobic power has a positive influence in high-intensity intermittent exercise. In addition, research (Jenkins et al., 1984) has shown positive correlation between oxygen uptake and antioxidant defense enzyme activity.

A result of the research (Table 1) has shown that $V0_{2max}$ values were statistically significantly higher in younger senior group of judokas in compared with other two groups. This results can be interpreted as indicating a need to improve the aerobic capacity in senior group of judokas. Several study showed that most of judokas have $V0_{2max}$ values between 50 and 60 ml/kg/min, using different protocols and equipment (Franchini et al., 2007, Trivic et al., 2009).

Like most other protective mechanisms in the body, the production of SOD decreases with age (Di Massimo et al., 2006), while a cell's susceptibility to oxidants increases, putting the cells under increasing oxidative stress. The SOD activity was linearly higher with age, as a consequence of longer training experience, which was expected as this enzyme undergoes exercise-induced adaptation. Statistically higher values of CAT and GSH-Px were noted also in senior age group (Table 2), in compared with group B. We consider that obtained results are consequence of age and low $V0_{2max}$ values in senior group of judokas. No change in GSH-R activity was observed between groups. Generally, there were only slight differences in the antioxidant enzyme activities (Table 2) between A and B groups, which correspond to findings of other researchers that antioxidant enzyme activity significantly changes only when ROS is produced in large quantities (Spasic et al., 1993). Data concerning the effects of a lower $V0_{2max}$ and increased antioxidant enzyme activities in senior age group of judokas are probably results due to differences in higher age of senior judokas and their lower fitness prepare in compared with group A and B.

Conclusion

Obtained data suggest that oxidative status parameters are adequately changeable in athletes, with different age and sport experience. Therefore, older athletes require higher intakes of antioxidants to defend against increased oxidative stress. Currently, from obtained results it is clear that athletes with higher sport experience have potential to result in increased free radical production, which may or may not result in acute oxidative stress. The present study revealed the need of antioxidant supplementation in judokas with higher sport experience, in compared to younger judokas. A significant increase in plasma CAT, SOD and GPX can be considered negative effects in senior age group of judokas, since certain biomarkers of oxidative stress are increased after judo training in senior age group. Age apparently plays a significant role in process that can lead to free radical generation in judokas. So, future research may investigate the methods of reducing macromolecule oxidation, possibly through the use of antioxidant supplementation and with improved aerobic capacity in senior group of judokas.

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