

Full Length Research Paper

Effects of acute exercise on some respiratory, circulatory and oxidative stress parameters of school boys aged 15-17 years

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The purpose of this study was to evaluate the effects of acute exercise on respiratory functions, heart-beats, blood pressure, total antioxidative capacity (TAC), oxidative stress index (OSI), lipid hydroperoxide (LOOHs) and Paraoxonase (PON) in school boys. A sample of 18 male amateur wrestlers are selected for this study. The participants perform exercise regularly at least four times a week and two hours a day. They participated in this study on voluntary basis. Respiratory frequency (RF), force expiratory volume (FEV1), Peak expiratory flow (PEF), heart-beats, (HB) systolic (SBP) and diastolic blood pressures (DBP) measures and blood samples were taken from the wrestlers before and right after the acute exercise programme. Their respiratory frequency, fev1, pef, heart-beats, sistolic and diastolic blood pressure, total antioxidant capacity (TAC), oxidative stress index (OSI), Lipid Hydroperoxide (LOOHs) and Paraoxonase (PON) levels were measured and assessed. It was found that wrestlers displayed significant increase in respiratory frequency, heart-beats ($p < 0.01$) and sistolic blood pressure, TAC, OSI values ($p < 0.05$), after the acute exercise compared to the pre-exercise levels. No significant change was observed in peak expiratory flow (PEF), force expiratory volume (FEV1), diastolic blood pressure, lipid hydro-peroxide (LOOHs) and paraoxonase (PON) levels. In this study, it was found that the balance shifted towards oxidative stress due to increased oxidants after the acute exercise programme. In order to reduce such a high oxidative stress and to prevent athletes from its adverse effects, it is necessary to have an antioxidant rich diet before any exercise or to get antioxidant supplements.

Key words: School boys, wrestling, curcuit explosive power training, respiratory functions, blood pressure, oxidant, antioxidant.

INTRODUCTION

Exercise disturbs the balance between free radicals and antioxidants and the resultant state is known as oxidative stress (Urso et al., 2003). During exercise, oxygen consumption is 10 to 15 times higher compared to a resting state and therefore the free radical production capacity of mitochondria increases temporarily (Tsai et al., 2001). The increase in O_2 uptake concomitant with physical exercise is related to a rise in the production of reactive

oxygen species (ROS) by cells and tissues.

The organism has an intracellular elements, the cellular membrane and extracellular liquids which helps to minimize the free radicals damage (Sen, 1995; Jenkins, 1988; Powers and Lennon, 1999). Blood, which ensures transportation of antioxidants all over the body, has a central role within the strategy of sustaining the Redox balance under oxidant conditions. Total antioxidant capacity (TAC) is considered as an indicator of capacity of the antioxidants within biological fluids to protect the membranes and other cellular components from oxidative damage (MacKinnon et al., 1999). Previous research indicated the effect of short term exercise on blood

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pressure (Pescatello et al., 1991; Johannes et al., 1995; Whelton et al., 2002), oxidative stress (Cooper et al., 2002; Urso et al., 2003; Roberts et al., 2002) and lipid hydroperoxide (Vincent et al., 2000; Roberts et al., 2002; Hamilton et al., 2001).

Exercise results in oxidant creation and oxidative stress due to its dual effect and also induces antioxidant synthesis (Ji, 1995). It is well-known that physical exercise may result in a shift in oxidant/antioxidant balance whose importance is well-proven in both physiological and pathological processes such as intracellular signal transmission, apoptosis, anti-microbial defense, muscular damage and fatigue, ageing, the Alzheimer's disease, some types of cancer, atherosclerosis, myocardial infarcts and ischemia/reperfusion damage (Atalay and Laaksonen, 2002).

Wrestling is a sport that requires various functional characteristics to coincide. Overall muscle strength, fast reaction times, neuromuscular coordination, static and dynamic balance, anaerobic power, and high aerobic capacity are factors that play a role in performance.

The aim of the current study was to reveal the changes in respiratory rate, peak expiratory flow rate (PEF), forced expiratory volume (FEV1), heart rate, blood pressure, and oxidant-antioxidant ratios in wrestlers by utilizing the fast circular strength training method. The oxidative stress index (OSI) and lipid hydroperoxides (LOOH) were evaluated in order to examine the effects of circular training on oxidative stress, and total antioxidant capacity (TAC) and paroxonase (PON) were evaluated as antioxidant parameters.

MATERIALS AND METHODS

Subjects

A total of 18 male amateur student wrestlers, who had 3 years of experience, were regularly training for 2 h daily four times a week, and participating in 10 to 12 tournaments annually, voluntarily joined the study. The subjects were informed not to eat or drink for three hours before the tests. Any subjects who smoked or had any chronic illnesses or asthma were excluded from the study. None of the subjects was taking any drug known to affect lipid and lipoprotein metabolism. Attention was paid to exclude subjects who were taking anabolic drugs, vitamins or other antioxidants, or who were smokers. None of the subjects was following a special diet. The quality, quantity and frequency of consumption of red meat, chicken, fish, eggs, vegetables, fruits, milky products and soft drinks was similar in all of the subjects. The study protocol was approved by the local Ethical Committee. Informed consent was obtained from all participants' parents.

Exercise program

The acute exercise programme was applied to the subjects. Workouts consisted of 8 different moves and stations. Each workout consisted of 3 sets with 5 min breaks in between. The duration of warm-ups and moves were 20 s with 30 s rest breaks in between. Workouts were applied with explosive tempo by two experienced trainers. 20 min warm-up exercise sessions took place prior to the

workouts. The total duration of workouts was 40 min. The stations that were performed in the workouts were: springing right and left with both legs over a 30 cm-high gymnastics bench, pull ups, 10 m runs, sit ups, jackknife position, push ups, jumping with both legs pulled up to the abdomen, and reverse sit ups.

Measurement methods

In the study, measurements were made before and right after the implementation of the circuit explosive power training program. Ages of the athletes were defined as years and their heights were scaled by a meter with 0.1 cm sensitivity and a metal rod attached to the meter. Weight was measured by means of a digital weighting machine with 0.01 kg sensitivity, respiratory functions with one flow tester screen spirometer while systolic and diastolic blood pressures were measured by means of a stethoscope and sphygmomanometer. The radial artery on the wrist was used to record the heart-beats. The pulse was recorded for one minute by putting the index finger and the middle finger on the artery. Venous blood samples were taken into tubes with EDTA for measurement of oxidant/antioxidant values. Total anti-oxidant capacity (TAC) was defined through a method that measures the total anti-oxidant capacity of the body vis-à-vis strong free radicals in accordance with the literature by Erel (2004). LOOH was measured by using a fullautomatic method developed by Arab and Steghens (2004), which utilizes xlenol orange and Fe⁺⁺. Oxidative stress index (OSI) was defined by a fullautomatic calorimetric method developed by Erel (2004). PON was measured by the method of Juretic et al. (2001) in Hitachi DP Modular Systems (Roche Diagnostics) analysis. Measurements of oxidant/antioxidant levels were performed in "Biochemistry Laboratory at Harran University Research Hospital.

Statistical analysis

In order to define the differences between the measurement results before and after the exercise, their arithmetical mean (X) and standard deviation (SD) were calculated; and in order to determine whether the difference between the arithmetic means within the same groups is as significant as 0.05, Paired-samples T-test was utilized. Statistical works were conducted through SPSS 16.0 for Windows.

RESULT

18 male student wrestlers with the mean age of 16.61 ± 0.69 years; weight 54.66 ± 11.4 kg, height 164.4 ± 9.33 cm, BMI 20.02 ± 2.5 kg/m² from the regional league participated in the study (Table 1).

After-exercise, respiratory frequency, heart-rates ($p < 0.001$) and systolic blood pressure increased significantly ($p < 0.05$), whereas, there was no significant changes in force expiratory volume, peak expiratory flow and diastolic blood pressure ($p > 0.05$) (Table 2).

According to the results obtained before and after exercise, total anti-oxidant capacity (TAC) and oxidative stress index (OSI) values of the subjects was found to be statistically significant at ($p < 0.005$) level. The scores obtained before and after exercise showed that lipid hydro-peroxide (LOOH) and paraoxonase (PON) values were not found statistically significant ($p > 0.05$) (Table 3).

The results revealed a significant increase in

Table 1. Anthropometric characteristics of the subjects (N=18).

Parameter	Mean±SD
Age (Years)	16.61 ± 0.69
Height (cm)	164.4 ± 9.33
Body weight (kg)	54.66 ± 11.4
BMI (kg/m ²)	20.02±2.5

respiratory frequency when the subjects' pre- and post-exercise respiratory functions were compared, while there was no significant difference between the (PEF) peak expiratory flow and (FEV1) force expiratory volume values.

DISCUSSION AND CONCLUSION

Studies on the effects of exercise on respiratory parameters in young individuals bring about different opinions. Some researchers argue that intense physical training has increasing effects on respiratory parameters (Açıkada, 1982; Çolakoğlu et al., 1984; Gözü et al., 1988), while others suggest that exercise does not affect respiratory parameters (Taşgın and Dönmez, 2009; Erdil et al., 1984; Mogulkoç et al., 1997). On the other hand, some researchers point out that the developments in respiratory parameters are in parallel to normal development as the dynamic of the age group (Akdur et al., 2001; Ergen, 1983).

The significant increase in respiratory frequency following the exercise program and the increase in the use up of O₂ and production of CO₂ during the exercises cause an increase in maximum minute ventilation, which is thought to be caused by the increase in respiratory volume and frequency (Tiryaki, 2002).

Comparison of pre- and post-exercise heart rates, and systolic and diastolic blood pressure values revealed significant increases in heart rates and systolic blood pressure values, but not for the diastolic blood pressure values (Table 2). Similar results have been reported by other researchers (Gökdemir et al., 2007; Ciloglu and Peker, 1999; Van Zant and Kuzma, 1993). The effects of exercise on heart rate and blood pressure are caused by the increases in heart rate volume and cardiac output. While vascular resistance decreases due to increased heart rate, blood pressure increases depending on the physical fitness of the athlete, and the type and intensity of the exercise. The increase in systolic and diastolic blood pressure during exercise is more significant in systolic blood pressure however, this change is observed much less in diastolic blood pressure. The results obtained in this study confirm the principle that when the increase in cardiac output particularly affects systolic blood pressure, it can increase up to 140 to 160 mm/Hg (Günay and Cicioğlu, 2001).

Statistically significant increases in total antioxidant capacity and oxidative stress index (OSI) were detected following the fast circular strength training that the wrestlers went through. There was no significant difference between the pre- and post-exercise LOOH (Lipid Hydroperoxide) and PON (Paraoxinase) levels (Table 3).

It has been indicated that different forms of exercises cause different levels of oxidative stress (Sen 1995; Alessio, 1993; Sen et al., 1994). Alongside many studies on the improvement of antioxidant defense system with long-term regular exercising (Di Massimo et al., 2004; Ji, 1995) indicated that high intensity exercise increases free radical production through increasing oxygen use up by 10 to 15 times, and that it causes oxidative stress and diminishes the antioxidant defense system (Fıçıcılar et al., 2003; Berlin and Colditz, 1990; Fletcher et al., 1995). It has also been reported that exercise does not affect antioxidant levels (Poulsen et al., 1996; Hartmann et al., 1994; Poulsen et al., 1999).

In a study, it was indicated that regular endurance and resilience exercises decrease oxidative stress and increase antioxidant levels (Jamurtas et al., 2003). In another study, Inal et al. (2001) determined that long- and short-distance swimming increases antioxidant enzyme activity. Leaf et al. (1999) reported that despite the fact that single-load maximal aerobic exercise causes oxidative stress, participating in regular physical exercises decreases the harmful effects of oxidation with the adaptation to exercise and exercise-related oxidative stress.

Evaluated along with the literature, the results of the current study revealed a significant increase in TAC in wrestlers following exercise. This increase in TAC values was both in line with some studies (Hartmann et al., 1994; Niess et al., 1996), and not with others (Finaud et al., 2006; Vina et al., 2000; Somani et al., 1995; Umegaki et al., 2000; Koyama et al., 1999). The significant increase in post-exercise TAC points to an increase in oxidant production along with increased metabolic rate.

In some studies, it has been indicated that oxidative stress-related parameters do not change following exercise (Subudhi et al., 2001; Koyama et al., 1999; Maughan et al., 1989), while some studies reported increases in the parameters (Leaf et al., 1999; Nevin et al., 2004; Finaud et al., 2006), and others reported decreases (Alpay et al., 2010; Dernbach et al., 1993; Chen, 2012).

The OSI values of the study group were determined to be significantly increased with fast circular strength training. The high OSI numbers following exercise and the exercise-related increase in oxygen use was thought to be associated with significantly high oxidative stress.

There are different results reported in the literature regarding the afore-mentioned issue. Some studies in the literature were in line with the current study results (Finaud et al., 2006; Viña et al., 2000; Somani et al., 1995; Umegaki et al., 2000; Koyama et al., 1999) and some were not (Hartmann et al., 1994; Niess et al., 1996).

Table 2. Comparison of respiratory frequency, FEV1, PEF, heart-rate, systolic and diastolic blood pressure values before and after exercise in wrestlers (n = 18).

Parameter	Before-test (Mean±SD)	After-test (Mean±SD)	T	Sig.
Respiratory frequency	17.72 ± 3.92	30.72 ± 4.02	-9.972	0.000*
FEV1 (L)	1.82 ± 0.66	1.68 ± 0.54	0.649	0.525
PEF (L)	424.16 ± 89.93	427.11 ± 107.22	-0.084	0.934
Heart-rate	66.33 ± 9.65	86.05 ± 17.5	-4.031	0.001*
Systolic BP (mmHg)	106.87 ± 9.46	114.37 ± 10.9	-2.324	0.035**
Diastolic BP (mmHg)	68.12 ± 7.71	69.44 ± 8.72	0.421	0.679

*P< 0.01; ** P < 0.05.

Table 3. Comparison of plasma TAC, OSI, PON and LOOH values before and after exercise in wrestlers (n = 18).

Parameter	Before-test (Mean±SD)	After-test (Mean±SD)	T	Sig.
TAC (mmol Trolox equiv./l)	0.93±0.17	1.03±0.11	-2.152	0.048**
OSI (mmol H ₂ O ₂ /l)	9.49±2.39	13.28±5.59	-2.384	0.030**
PON (U/L)	56.94±109.2	132.58±81.0	1.173	0.258
LOOH (mmol H ₂ O ₂ Eqiv./L)	3.87±0.96	3.54±0.89	0.996	0.334

*P< 0.01; **P < 0.05.

There are individuals from societies with different socio-economic levels, individuals with different age and sex from various branches of sports, and individuals performing different kinds of exercises with varying durations and intensities. This makes it harder to compare and evaluate the results obtained via different methods, study groups and techniques. This might be the reason for the similarities and differences between the current study results and other results from other studies in the literature.

Therefore, although short time intense exercises increases oxidative stress and antioxidant capacity in adolescent wrestlers, regular and habitual physical activity can favorably affect antioxidant potential and prevent lipid peroxidation. Antioxidant supplements could be useful to decrease oxidative stress and increase antioxidant capacity in exercising people. And antioxidant supply may increase performance of exercising people.

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