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The effect of extreme sports on oxidative stress

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A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

Eser Aggon[1ABCD], Ozturk Agirbas[2ABCD], Izzet Ucan[2ABCD], Anthony C Hackney[3,4ABCDE]

[1] College of Physical Education and Sports, Erzincan University, Erzincan, Turkey
[2] College of Physical Education and Sports, Bayburt University, Bayburt, Turkey
[3] Department of Exercise and Sport Science, University of North Carolina, Chapel Hill, USA
[4] Department of Nutrition, University of North Carolina, Chapel Hill, USA

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Abstract

Background & Study Aim: Despite the high risk of extreme sports, participation rates have increased in the last years. Rafting and paragliding are two of the most popular extreme sports. The aim of this study was the effect of rafting and paragliding exercises in males on oxidative stress situation and antioxidant status.

Material & Methods: Seventeen male rafters and ten male paragliders voluntarily participated in the study. The inclusion criteria were: non-smoker, no known history of cardiovascular disease, body mass index (BMI) <30 kg/m2, and no intake of medications or antioxidant supplements. Blood samples were taken at rafting and paragliding practices' a day before and after the sporting activities. The data were statistically analysed with Wilcoxon and Mann-Whitney U tests.

Results: Rafting activity increased the values of the total antioxidant situation (TAS), paragliding exercises decreased the level of TAS while paragliding increased the level of total oxidative stress (TOS). Differences existed between the group only before activities in TAS values.

Conclusions: The specific property of the rafting workout is to stimulate of participants to cope with oxidative stress by activating the antioxidant status. In turn paragliding exercises increase oxidative stress due to the danger element in the sport and perhaps requiring the participants stay at a high altitude, in some situations, during its practice.

Keywords: haematocrit • haemoglobin • malondialdehyde (MDA) • paragliding • rafting

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Author's address: Eser Aggon, Erzincan University, College of Physical Education and Sports, Erzincan, Turkey; e-mail: eaggon@erzincan.edu.tr

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Extreme sport – *noun* a sport considered more dangerous and thrilling than ordinary sports and often involving hazardous airborne stunts and tricks [23].

EFPA – "extreme form of physical activity are extreme sports, often classified according to the environment in which they are performed (water, land, air), extreme form of physical recreation as well as gainful activity or voluntary service, and all varieties of physical activity that meet at least one classification criterion of the feature associated either with extreme risk of injury or death, or extreme body burden with high level of effort, or extreme coordination difficulty" [24, p. 19].

Oxidative stress – *noun* damage to cells caused by free radicals produced in aerobic metabolisation [23].

Malondialdehyde (**MDA**) – is the organic compound with the nominal formula $CH_2(CHO)_2$. It is a colourless liquid.

Antioxidant – *noun* a substance that makes oxygen less damaging, e.g. in the body or foods or plastics [23].

Plasma – *noun* **1.** a yellow watery liquid which makes up the main part of blood **2.** lymph with no corpuscles **3.** cytoplasm [23].

INTRODUCTION

Extreme or adventure sports participation is typically the result of a series of social factors such as; need for self-expression and change, (re)discovery of nature, physical practice, contemplation, overcoming one's own limits, leisure, ability to experience strong emotions, pleasure, freedom, health promotion, and quality of life [1]. Despite the high risk of extreme sports [2], participation rates have increased in the last years [3]. Rafting and paragliding are two of the most popular extreme sports [4]. Rafting is an activity where (usually) between four and eight individuals use a single inflatable craft negotiate a certain distance on a river. Individuals sit side by side and use a single-bladed paddle to propel and steer the craft [5]. Rafting participants should know the required basic techniques, as well as know-understand the water flow rate of rivers. Paragliding is an extreme sport were participants fly with a parachute from an elevated spot to the surrounding ground. Paragliding practitioners must understand aspects of flight techniques, as well as weather information. In each of these sports, it is criteria the participants understand and carefully calculate every possible risk to guarantee safe and pleasurable participation [6].

Little is known about stress reactivity of athletes who participate in extreme sports despite their increasing popularity [2]. Scientific knowledge about the biological implications of exercise-induced oxidative stress has expanded rapidly in the last few years [7]. Oxidative stress is an imbalance between the generation of reactive oxygen species and the antioxidant defence system of the body [8]. Oxidative stress state (status) is potentially one of the most important indicators of what effect extreme sports participation is having on the physiological state of an athlete.

Reactive oxygen particles and antioxidant system markers are used in determining oxidative stress status. Malondialdehyde (MDA), a product indicative of the result of lipid peroxidation, is one of the markers used to measure the level of oxidative stress [9]. There are different oxidant substances in plasma or serum other than MDA. In addition, total oxidative stress status (TOS) measurements constitute an important method of oxidative stress measurement that is used in terms of being economical and allowing for the interpretation of different oxidant indicators together [10]. However, glutathione peroxidase (GPx), which is responsible for the destruction of intracellular hydroperoxides, is the most effective of antioxidant enzymes [11]. Total antioxidant status (TAS) is the total action of all antioxidants present in plasma and body fluids, both endogenously and exogenously, and is a combined indicator of measurable antioxidants, rather than a simple sum of these [12].

To date, it appears that the number of studies examining the oxidative stress encountered by athletes participating in extreme sports is very limited. Therefore, the aim of this study was the effects of rafting and paragliding exercises in males on oxidative stress situation and antioxidant status.

MATERIALS AND METHODS

Participants

A total of 17 rafting and, 10 paragliding participants voluntarily participated in the study. They were not rafting and parachuting practice in advance. The rafting group had 17 male (age: 22.24 **±3.07** years; height: 179.65 **±6.61** cm; weight: 73.59 **±7.77** kg; BMI: 22.8 ±1.99 kg/m^2); paragliding groups were 10 male (age: 28.2 ±10.28 years; height: 176.00 ±8.19 cm; weight: 76.8 ±16.12 kg; BMI: 24.66 ±3.93 kg/m^2).

The inclusion criteria were: non-smoker, no known history of cardiovascular disease, body mass index (BMI) <30 kg/m^2, and no intake of medication or antioxidant supplements. All participant filled volunteer consent forms. Both groups of subjects were classified as having moderate levels of fitness based upon their regular physical activity behaviours.

Training protocols

Participants in this study were novices and hence given basic rafting and paragliding technical and safety training by experts 5 days a week for the 2 weeks before the study.

The rafting exercises were applied in the river with a rapid difficulty rating of 3 class at an altitude of 1150 meters [13]. Paragliding exercises were applied by flying from a vertical slope surface at an altitude of 1500 m. All rafting and paragliding exercises were standardised for 20 minutes. This was done so the oxidative stress state between the two groups could be equally

compared.

Collection of blood samples

Participant blood samples were taken for each rafting and paragliding practices' a day before at 09.00 a.m (*pre*), and immediately 15 minutes after practices' at (*post*) at 09:00 a.m.

All blood samples were drawn in EDTA-treated tubes and placed on ice until processing. Whole blood aliquot samples were analysed for hematocrit (Hct) and haemoglobin (Hb). Remaining sample aliquots were centrifuged at 4 °C for 15 min at 3000 rpm (Centra-8R IEC, MA). Separated plasma was frozen at −80 °C until oxidative analysis.

Biochemical assays

In order to determine whether there are a difference rafting and paragliding groups *pre* and *post*-exercise values of the Oxidative Stress markers. Malondialdehyde (MDA) levels, glutathione peroxidase (GPx) activities, Total Antioxidant Status (TAS) and Total Oxidative Status (TOS) in serum were all determined spectrophotometrically using commercially available EL□SA assay kits (Shanghai Sunred Biological Technology Co., Ltd, Shanghai, China) following the manufacturer's protocols.

Statistical analyses

Statistical analyses were carried out using the SPSS 19. Normalization analysis was performed to determine whether the data were normally distributed and it was determined that the data set was not normally distributed. Therefore, Wilcoxon test was used to compare intra-group values of the rafting and paragliding participating in the study and Mann-Whitney U test was used for inter-group comparisons. Values represent Mean ±S.E. *p<0.05; a: statistically significant difference from baseline.

RESULTS

There was a significant increase after exercise in TAS values, but there was no significant difference after exercise values for GPx, TOS or MDA. Also, there was a significant decrease in TAS values and an increase in TOS after paragliding exercise. There were, however, no difference GPx and MDA values (Table 1).

There were a significant difference TAS value between rafting and paragliding groups only at the before exercise comparison. There was no difference between rafting and paragliding groups for the values of MDA, TOS, or GPx (Table 2).

Table 1. The results of before and after exercise (Wilcoxon test for TOS, MDA, TAS and GPX).

Variables & indicators		Rafting					Paragliding				
	N	Mean rank	Med	Z	P	N	Mean rank	Med	Z	P	
TOS µmol/L	before exercise	17	8.00	4.78	−.544	.586	10	.00	4.09	−2.023	.043*
	after exercise	17	10.83	4.33			10	4.00	5.22		
MDA nmol/ml	before exercise	17	12.63	86.51	−1.160	.246	10	2.50	84.16	−.674	.500
	after exercise	17	5.78	62.68			10	5.00	87.77		
TAS mmol/L	before exercise	17	7.88	1.11	−2.131	.033*	10	3.,00	1.78	−2.023	.043*
	after exercise	17	9.35	1.47			10	.00	1.56		
GPX U/ml	before exercise	17	9.50	345.18	−.923	.356	10	2.50	406.93	−.674	.500
	after exercise	17	8.73	352.43			10	3.33	439.18		

TOS Total Oxidant Status; MDA Melandialdehit; **TAS** Total Antioxidant Status; GPx Glutathione Peroxidase; values represent mean ±S.E. *p<0.05 (statistically significant difference from baseline).

Table 2. The results of between the rafting and paragliding TAS, GPX, TOS and MDA values with Mann Whitney U Test.

Variables & groups		N Mean rank	Before exercise				After exercise			
			Med	Z	P	Mean rank	Med	Z	P	
TOS µmol/L	rafting	17	12.53	4.78	−1.371	.170	10.76	4.33	−.980	.327
	paragliding	10	8.00	4.09			14.00	5.22		
MDA nmol/ml	rafting	17	11.41	86.51	−.118	.906	11.53	62.68	−.039	.969
	paragliding	10	11.80	84.16			11.40	87.77		
TAS mmol/L	rafting	17	9.24	1.11	−3.017	.003*	10.88	1.47	−.823	.411
	paragliding	10	19.20	1.78			13.60	1.56		
GPX U/ml	rafting	17	11.29	345.18	−.274	.784	11.47	352.43	−.039	.969
	paragliding	10	12.20	406.93			11.60	439.18		

Values represent mean ±S.E. *p<0.0 (statistically significant difference from baseline).

DISCUSSION

Findings show that acute effects within the sports activities are relatively consistent, and only minimum effects exist between the activities. Most of the studies on rafting, paragliding, and extreme sports have been conducted to examine the risks of these sports [4], the psychological characteristics of the participants [14] and their disability [15]. However, studies on the oxidative stress status and antioxidant capacities of these sporting activities are very limited. Hence our data are new and novel.

It is known that the effects of acute exercises on oxidative stress vary according to their types and intensities [7]. The fact that extreme sports are practised in the form of varying types and intensities (i.e., physical demands), in addition to being performed in outdoor environmental dangerous conditions of different difficulties which can all lead to potentially different levels of oxidative stress.

In this study, no significant differences were found in the MDA and TOS values that are oxidative stress status markers and in the GPX value which is an antioxidant status marker, after acute rafting exercises, while it was determined that the Total Antioxidant Status value have increased significantly (Table 1). The fact that the river difficulty level of the rafting area was 3 may be the reason that there was no effect on the oxidative stress status, as this level of river classification is only moderately difficult. Also, the fact that rafting exercises are a team activity and not truly individual may be another reason (i.e., less individual stress). It can be argued that rafting, as within this study, was lower risk and not strenuous enough to raise the oxidative stress level significantly. To this end, Reid [16] and Pingitore et al. [17] have stated that exercises with high intensity and strenuous components induce an overproduction of ROS.

While MDA did not change after acute paragliding exercises, TOS values increased significantly, but GPX values did not differ. Interestingly, a significant decrease in TAS values was noted at the end of the same practice (Table 1). Altitude changes are known to be related to oxidative stress. It has been stated that as the altitude increases, there is an increase in free radicals and oxidative stress increases [18]. In a study conducted to determine the oxidative stress status of parachuters, Deinzer et al. [19] reported significant increases in cortisol, another oxidative stress status determinant, during the jump. A similar result was reported by Filaire et al. [14]. In this latter study, they noted that the cortisol values of the paragliders increased significantly during the day of the jump and were high throughout the competition. In the research he conducted on ski jumpers, which is another sporting activity that involves a rapid movement from a high altitude downward, much like paragliding, Aggon [20], stated that there were increases in MDA values after only

3 jumps., In the current study we believed that the increase in TOS in the paragliding exercise might be due in part to the altitude exposure. Indeed, the paragliding group participated at a geographical location with an altitude of approximately 1600 m and then continued their flights at a similar altitude for about 20 minutes. Several researchers indicate that in addition to physiological stressors, psychological (fear, anxiety, etc.) and environmental stressors such as altitude may also affect oxidative stress status [21, 22].

When the oxidative stress and antioxidant activity levels of rafters and paragliders were compared in our study, there was a difference in favour of paragliders only in TAS values before exercise, while no difference was found in MDA, TOS, and GPX values in the post-exercise comparisons (Table 2). Why this occurred is clear and in need of further research in the future. It should be noted by the after exercise exposure the groups did not differ on TAS. The increasing popularity of not only extreme sports but the broadly understood "extreme form of physical activity" (EFPA) [24] is likely to intensify the study of phenomena from this area. It is impossible to overestimate the cognitive and application values of future interdisciplinary research – from recreational EFPA to application in defence formations and emergency services [25].

CONCLUSIONS

The specific property of the rafting workout is to stimulate of participants to cope with oxidative stress by activating the antioxidant status. In turn paragliding exercises increase oxidative stress due to the danger element in the sport and perhaps requiring the participants stay at a high altitude, in some situations, during its practice.

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