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Comparative evaluation of MDA levels during aerobic exercise in young trained and sedentary male subjects

Sermin Algul[1], Seda Ugras[2], Mehmet Kara[1]

[1]*Van Yuzuncu Yil University, Faculty of Medicine, Department of Physiology, Van, Turkey*
[2]*Inonu University, Faculty of Medicine, Department of Physiology, Malatya, Turkey*

Abstract:

The impacts of acute aerobic exercise on oxidative stress as determined altered MDA levels have been examined in young trained and sedentary male subjects.
Total of 20 (10 trained and 10 sedentary) male subjects performed an aerobic cycling exercise at the anaerobic threshold for about 30 min. The venous blood samples (pre and post exercise) and analysed for MDA using HPLC methods. Wilcoxon and Mann Whitney U-tests were included in the statistical methods for data analysis.
Acute exercise caused a systematic increase in MDA levels in trained (36.2%) and sedentary (55.4%) subjects during exercise (p<0.001). The increase in MDA levels were higher in sedentary subjects (0.79±0.08 μmol/L vs 1.02±0.05 μmol/L) compared to trained subjects (0.73±0.05 μmol/L vs 0.97±0.07 μmol/L) (p<0.001).
Acute exercise may cause higher levels of increase in oxidative stress as determined alteration of MDA levels in sedentary subjects. Thus the sedentary subjects should pay more attention to the physical activities.

Key Words: MDA, oxidative stress, metabolism, aerobic exercise, acute exercise

Introduction

It is well known that regular physical activities are important for improvement of human health (1, 2). Regular physical activity and exercise studies have a major importance in the treatment, rehabilitation and prevention of various diseases including cardiac, metabolic, and respiratory systems (1, 3, 4). However, despite the beneficial effects on health, acute exercise may also cause an increased oxidative stress in the body (5). Malondialdehyde (MDA) is the main form of aldehyde resulting from tissue lipid peroxidation and widely used as a biomarker of oxidative stress (6, 7) and clinically serious metabolic impairments (8). Anaerobic exercise is already known to be the cause of oxidative stress and increased lipid peroxidation (9, 10).

However, aerobic exercise mediated responses of MDA in trained and sedentary subjects seem to be not well known (11).

In this present study, we comparatively tried to investigate the impact of aerobic exercise on MDA levels in subjects with high fitness levels (trained) and subjects with normal fitness levels (sedentary).

Materials and Methods

Subjects: The University's ethics board approved the study protocol. A written informed consent was provided by the all subjects involved in the study.

A total of 20 (n=10 sedentary and n=10 trained) young healthy volunteer male subjects were enrolled in this study. Table 1 indicates the basic features of the participants at the beginning of the study.

Trained subjects: -An anamnesis of regular training for at least 5 years with an exercise frequency of at least three times per week.

Sedentary subjects: -No more than 1 h/week of organized exercise for at least 1 year.

The body composition of all participants was measured by the use of leg-to-leg bioelectrical impedance (Tanita Body Fat Analyser, TBF 300 M, Tanita, Tokyo, Japan) (12).

Exercise Protocols: Each subjects performed an aerobic cycling exercise on a computer controlled, electromagnetically braked cycle ergometer (Lode, Examiner Groningen the Netherlands) (30 min) in an air-conditioned laboratory. Aerobic exercise protocols were chosen between 64-76 % of maximal heart rate

*Corresponding Author: Dr. Sermin Algul, Yuzuncu Yil University, Faculty of Medicine, Department of Physiology, Van, Turkey
E-mail: serminalgul@hotmail.com-serminalgul@yyu.edu.tr, Telephone: +9(0432) 225 17 01 ext 25184, Fax: 0 (432) 216 75 19
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Table 1. Physical characteristics of the subjects, fat free mass (FFM) and fat mass (FM)

	Age (yr)	Height (cm)	Weight (kg)	FFM (kg)	FM (kg)
Trained	21.2±0.6	171.8±2.2	62.9±1.6	57.44±1.41	5.43±0.46
Untrained	23.4±0.5	172.0±0.8	63.3±1.6	57.09±1.04	6.39±0.64

according to American College of Sports Medicine (13). The cardiac rhythm rate was evaluated during the test using a heart-rate monitor (Polar Heart Watch T31-CODED, China) to ensure that subjects kept at their ordered intensity.

Blood collection and biochemical analysis: Venous blood specimens were drawn from the antecubital vein in aprotinin-included tubes before the activity as a baseline and just after the finishing of the exercise. Blood samples were separated and directly centrifuged at 4000 rpm at 4°C for 5 min to provide serum samples; it was then frozen and stored at –80°C for the following examinations applied within 4 weeks. The samples were studied for MDA in a double-blind condition.

Serum MDA measurements were determined by High Performance Liquid Chromatography (HPLC) methods using commercial kit (Immu Chrom GmbH Tiergartenstr. 7 D 64646 Heppenheim IC 1900). The intra and inter-assay of variation and sensitivity for MDA were 9% (0.86 μmol/L) - 6.4% (2.55 μmol/L), 10.9% (0.89 μmol/L) - 7.5% (2.5 μmol/L), respectively. MDA measurement by the use of HPLC is the most favourable methods for precise analysis of MDA in sports and exercise field because of its sensitivity and accuracy (14).

Statistical analysis: SPSS 22 programme was used for statistical analysis in this study. Data are stated as mean (± standard error of Mean [SEM]). The Wilcoxon test, which is a nonparametric comparison, was included in the statistical analysis to measure the significance of within-group comparisons of the data. The statistical analyses of between-group data were performed using Mann Whitney U-test. p<0.05 indicated the statistical significance.

Results

The MDA values in response to the aerobic exercise performed in both groups are presented in Figure 1. There were statistically significant variations in before and after period of exercise (mean ± SEM) MDA levels in trained (0.766±0.04 μmol/L vs. 0.960±0.06 μmol/L, p < 0.05) and in sedentary (0.809±0.03 μmol/L vs. 1.256±0.07 μmol/L, p < 0.05) groups, respectively (Figure 1).

MDA levels increased in all subjects in both groups. However, there was no significant difference in basal MDA levels in the exercised group with comparison to those of the sedentary group (Figure 1).

The percentage increase of MDA levels at the end of the exercise was found to be significantly higher in sedentary groups (54.9±4.7%) compared to trained group (24.3±3.4%) (p < 0.05) (Figure 2).

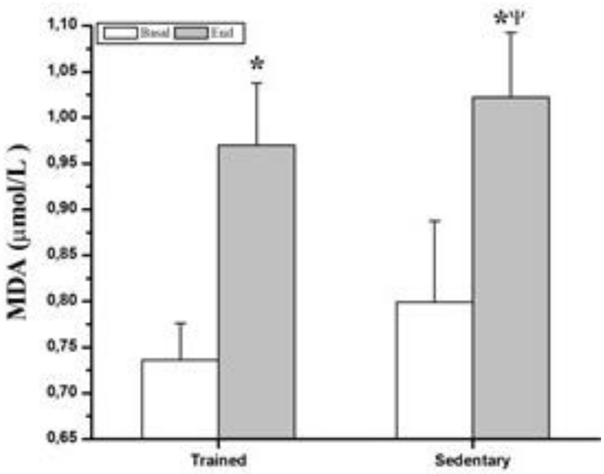

Fig. 1. Mean (± S.E.) values of MDA in both the baseline (white column) and end-exercise (grey column) in trained and sedentary subjects in aerobic exercise.

The symbol * represent statistically significant differences between basal and end-exercise values ($p < 0.05$).

The symbol Ψ represent statistically significant differences end-exercise values between sedentary and trained subjects ($p < 0.05$).

Discussion

In our study, the comparative evaluation of MDA levels in trained and sedentary subjects during acute aerobic exercise showed significantly higher percentage of increases in MDA levels in sedentary subjects (54.9%) compared to the trained subjects (24.3%) (Figure 2).

It has been reported that intense and/or heavy exercise stimulates lipid peroxidation (15-17). In this study anaerobic threshold based exercise protocol applied to subjects which is characterised as moderate intensity (18). Trained subjects could perform exercise with less oxidative stress compared to sedentary subjects (19). Regular aerobic exercise training may improve oxidative system and reduce oxidative stress (20).

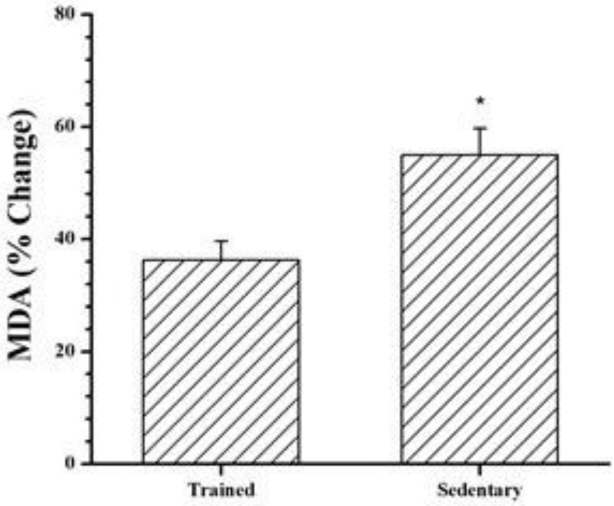

Fig. 2. Mean (± S.E.) percentage change of MDA levels in the trained (*n*=10) and sedentary groups (*n*=10) during the aerobic exercise
The symbol * represent statistically significant differences between sedentary and trained subjects ($p < 0.05$).

The results from human and animal studies suggested that increased metabolic activity lead to significant changes in body biomolecules and oxidative systems (21). Exercise-induced oxidative damage in tissues has been shown to damage cellular membranes, induce cellular swelling, reduce cell membrane flow, maintain the ionic gradient, and cause tissue inflammation, DNA damage, and protein changes (22). The increase in MDA level has been reported to impair the metabolism, integrity and performance of muscle cells (22). It has been suggested that a decrease in the level of lipid peroxidation associated with regular exercise may be due to the increased level of antioxidant capacity (23). The high fitness status of the subjects may elevate the resistance of skeletal muscle to damages result from lipid peroxidation (24). However, the basal MDA levels of sedentary subjects were not found to be higher than basal MDA levels of the trained subjects.

Considering higher percentage increases in MDA levels during an acute aerobic exercise in sedentary, more attention should be taken when performed heavy and longer physical activities.

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