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Response of Zinc Levels During Aerobic Exercise: A Special Connection between Increased Metabolic Stress and Altered Oxidant to Antioxidant Balance

"Aerobik Egzersiz Sırasında Çinko Seviyelerinin Cevabı: Artan Metabolik Stres İle Değişen Oksidan Ve Antioksidan Denge Arasında Özel Bir Bağlantı"

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REVIEW

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ABSTRACT

Aim: It was aimed to evaluate aerobic exercise induced metabolic stress on plasma zinc levels and its connection with oxidant antioxidant status.

Material and Method: Thirty sedentary male performed a 45 minutes of running exercise at the work load correspond to lactate threshold reflecting moderate aerobic intensity. Blood samples were taken before and after exercise. Plasma zinc, malondialdehyde (MDA), total oxidant status (TOS) and total antioxidant status (TAS) were measured using HPLC and ELISA kits.

Results: Exercise resulted significant decreases in zinc levels which is closely associated with increased TOS and MDA levels.

Conclusion: Zinc shows great influence on aerobic exercise induced increased metabolic stress as indicated with significant alteration in TOS, TAS and MDA levels. Thus zinc supplement should be considered during long period high intensity exercise to support muscle damaged.

Keywords: Exercise, Zinc, Oxidative stress, TAS, TOS

ÖZET

Amaç: Aerobik egzersize bağlı metabolik stresin plazma çinko düzeyleri ve oksidan antioksidan durumu ile ilişkisinin değerlendirilmesi amaçlandı.

Gereç ve Yöntem: Otuz sedanter erkek, orta derecede aerobik yoğunluğu yansıtan laktat eşiğine karşılık gelen iş yükünde 45 dakikalık koşu egzersizi yaptı. Egzersiz öncesi ve sonrası kan örnekleri alındı. Plazma çinko, malondialdehit (MDA), toplam oksidan durumu (TOS) ve toplam antioksidan durumu (TAS), HPLC ve ELISA kitleri kullanılarak ölçüldü.

Bulgular: Egzersiz, artan TOS ve MDA seviyeleri ile yakından ilişkili olan çinko seviyelerinde önemli düşüşlere neden oldu.

Sonuç: Çinko, TOS, TAS ve MDA düzeylerinde önemli değişiklik ile belirtildiği gibi, aerobik egzersizin neden olduğu artan metabolik stres üzerinde büyük bir etki göstermektedir. Bu nedenle, uzun süreli yüksek yoğunluklu egzersiz sırasında hasarlı kasları desteklemek için çinko takviyesi düşünülmelidir.

Anahtar Kelimeler: Egzersiz, Çinko, Oksidatif stres, TAS, TOS

INTRODUCTION

It is generally accepted that physical activity is a valuable tool in the preventative and treatment strategy for many cardiorespiratory and metabolic diseases and other chronic diseases (Ozcelik et al., 2015 & Sietsema et al., 2020). In addition to many beneficial effects of exercise on improvement of body composition, increased fat oxidation, insulin homeostasis, exercise has significant impacts on increased metabolic stress, impairment of oxidant antioxidant status and disarranged of levels of some trace elements (Algul et al., 2019).

Zinc (Zn) is one of the important trace elements that have significant roles in energy metabolism and antioxidant effects (Gulbahce et al., 2021 & Ugurlu et al., 2022). The zinc transport and buffer protein systems are two important factor regulating zinc homeostasis between cell, blood and body (Chu et al., 2016). Impaired cardiorespiratory function and reduced muscle activity during exercise in zinc depleted subjects has been shown (Lucasci, 2005). Thus zinc becomes an important element when considering the subject's physical activity and fitness status levels. Exercise is known to increase malondialdehyde (MDA) levels (Algul et al., 2018). The alteration the levels of total antioxidant status (TAS) and total oxidant status (TOS) during exercise has been reported (Thirupathi et al., 2021 & Ugras et al., 2022). The any possible connection between metabolic stress oxidative stress and zinc levels needs to be investigated. The purpose of this study was to evaluate the impact of aerobic exercise induced increased metabolic stress determined as the change of malondialdehyde, total oxidative status (TOS) and total antioxidant status (TOS) on serum zinc levels in young sedentary males.

MATERIAL AND METHODS

Total of 30 healthy male (age: 22.5 ± 1.8 yrs, BMI: 21.8 ± 1.7 kg/m^2) performed an approximately 45 min of running test (between 08:00 A.M. to 09:00 A.M.). The subjects were instructed to avoid any heavy exercise before the test (at least 72 hours). The exercise intensity established using the lactate threshold which was estimated from the percent of age predicted maximal heart rate values (Ugras and Ozcelik 2020). Polar hear rate monitor used to adjust to follow exercise training heart rates. Ethical approvement was obtained from the local ethical committee. He subjects should be in sedentary condition with normal body composition (BMI between 18.5 kg/m2 to 25 kg/m^2). The subjects did not include who has smoking, taking alcohol or any medication, or any metabolic or cardiovascular diseases. Body composition analysis were performed using foot to foot bioelectrical impedance analysis (Ugras, 2020)

Blood samples (5 ml) were taken before and immediately at the end of the test in to the EDTA containing tubes. Then, the samples centrifuged, serum separated and stored in -80 C until the analysis. A flame atomic absorption spectrometer and HPLC used to determine Zn and MDA levels, respectively. During exercise total antioxidant status (TAS) and total oxidant status (TOS) were determined using Enzyme Linked Immunusorbent assay (ELISA).

The data were expressed mean±SE. A paired-t test used to analyse the significance of pre-post exercise data. Linear regression analyses used to compare changes of MDA, TAS, TOS and Zinc $P<0.05$ as accepted as statistically significant.

RESULTS

Aerobic exercise induced metabolic stress caused significant changes in MDA, zinc, oxidant and antioxidant status of the subjects. Exercise lead to a significant decrease in zinc level from baseline (mean±SE) value of 1.3266±0.03 µmol/L to 1.023±0.02 µmol/L at the end of the test ($p<0.05$).

In contrast, exercise caused a significant increase in MDA level from baseline value of 0.834±0.02 µmol/L to 1.139±0.02 µmol/L at the end of the test ($p<0.05$). As shown in Figure 1, there was a negative significant correlation between increased MDA and decrease in Zn levels: R : -0.56223 (p=0.0001).

Exercise caused significant increasein TOS levels: from onset 13.83±0.47 mmol/L to 19.54±0.77 mmol/L end of exercise and significant decrease in TAS from onset 1.023±001 mmol/L to end of exercise 0.834 ± 0.01 mmol/L.

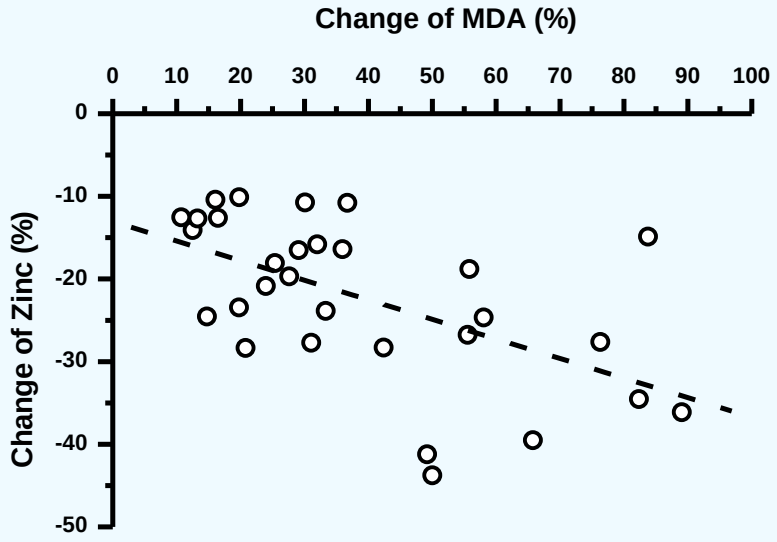

Figure 1. *Negative Linear Correlation Between Percent Change Of MDA And Zinc Levels During Exercise (R = -0.56223, p = 0.001).*

In addition, a negative significant correlation between change of TOS and zinc levels has been observed. (Figure 2).

We have observed no significant correlation between change of zinc levels and total antioxidant status (R = 0.07046, p=0.7)

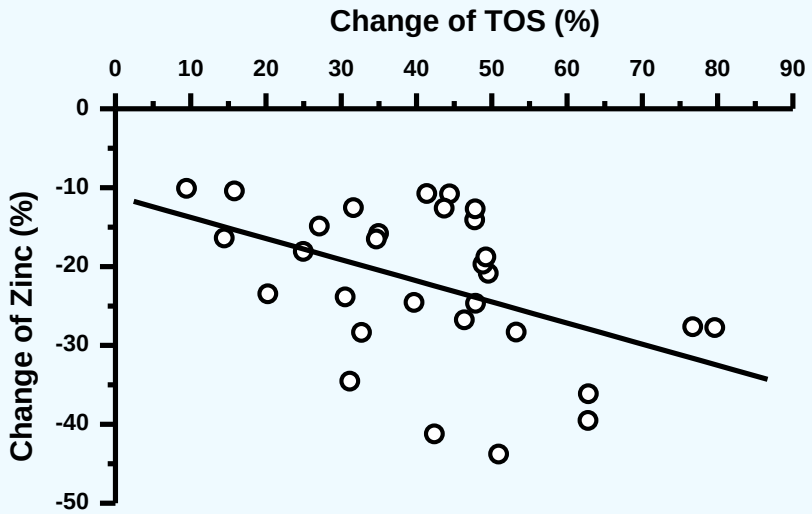

Figure 2. *Negative Linear Correlation Between Percent Change Of Total Oxidant Status (TOS) And Zinc Levels During Exercise (R = -0.45861, p = 0.01).*

DISCUSSION AND CONCLUSIONS

Aerobic running exercise that indicates moderate intensity, caused markedly increase in metabolic stress as determined by and 38% of increase in MDA levels (Ozcelik and Karatas, 2008 & Algul et al., 2018). Interestingly, during acute aerobic exercise, decreased zinc levels have been correlated with increased lipid peroxidation markers (i.e. MDA) (Figure 1).

Muscular contraction has also significant impacts of plasma zinc levels leading systematic decreases (-22%) (Chu et al., 2016, Algul et al., 2022). Aerobic exercise is also lead to significant decrease in TAS (-18%) and significant increase in TOS (41%) (Ugras and Dalkılıç, 2021).

The present study revealed that aerobic exercise at the moderate intensity has significant disturbance to body zinc homeostasis which is closely related altered metabolic stress. This is because antioxidant effects of zinc in human health and diseases has been shown (Olechnowicz e al., 2018 & Prasad and Bao, 2019). Actually exercise induced increased oxidant production could be a stimulus to muscle adaptation to imposed exercise (Bailey et al., 2007).

During exercise, increase in metabolic stress and decrease in antioxidant vitamin levels has been shown (Ozcelik and Karatas, 2008). In addition, antioxidant supplement prior to the exercise protects against exercise induced metabolic impairments (de Oliveira et al., 2019)

In this study, the subjects group contained healthy and preforming not a regular exercise training. It is known that fitness status of the subjects may have an impact on oxidative stress levels (Ozcelik et al., 2005 & Toro-Románet al., 2022) determined by an increased MDA and TOS. It has been reported that zinc has significant impacts on muscle regeneration Hernández-Camacho et al.,2020) and protection on neurodegeneration (Algul et al., 2021).

The observation of association between decreased Zn and increased metabolic stress during aerobic exercise may lead a consideration of additional zinc supplementation in subjects with higher metabolic stress. Considering the beneficial effects of zinc in oxidative stress induced muscle damaged, zinc supplementation could be requiring after exercise.

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