Original Article

Comparison of Cortisol and Some Physiological Biomarkers Among Athletes Following a Basketball Sports Performance

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Abstract:

The current study was designed to investigate the effect of exercise on the level of the cortisol hormone and some physiological variables in male athletes. The cortisol, vitamin C, glutathione (GSH), and malondialdehyde (MDA) levels in the serum of twenty young male basketball players were measured before and after the exercise. The cortisol values and GSH levels showed a statistically significant decrease after physical effort compared to the result before training, in contrast to vitamin C and MDA levels represent a statistically significant increase. Decreasing cortisol levels after activity showed decreasing stress because exercise for years will reduce the stimulating effect of cortisol secretion. In addition, in response to increased oxidative stress caused by exercise, serum vitamin C increased to prevent oxidative stress. As a result, training in these athletes led to producing reactive oxygen species and thus increased lipid peroxidation, which increased MDA levels by exhausting the antioxidant defense system and reducing GSH levels. Measurement of these biomarkers allows the identification of players affected by severe oxidative stress and indicates the time of intervention for improving their performance and health.

Keywords: Cortisol, Glutathione, Vitamin C, Malondialdehyde, Exercise

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Introduction:

Sports activities are among the main ways to control and prevent chronic diseases such as cancer, Alzheimer's, and cardiovascular diseases. Performing regular sports activities by creating cellular adaptations and increasing antioxidant enzymes can improve the body's antioxidant potential to deal with oxidative conditions.[1] Basketball is one of the most popular sports around the world. It has attracted many spectators because of its dynamic features. Both aerobic and anaerobic systems are activated to perform the movements of this sport. Previous research has shown that anaerobic metabolism is the main energy pathway activated in basketball players (Ciuti *et al.*, 1996).

Cortisol is one of the most important hormones that regulate the metabolism of sugars and fats, which causes the release of lipids from fat tissues. This hormone causes more use of carbohydrates as a fuel source and thus increases energy production in muscle cells.[2,3] In the field of changing the cortisol level in various sports, studies have been conducted, including in football players,[4] weightlifters [5] and strength sport.[6] Various studies have also investigated changes in

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cortisol levels in basketball players [7,8]. Stress is one of the external factors that directly affects the stimulation and secretion of cortisol. The longer the exercise, the higher the cortisol levels [9,10].

Vitamin C, or ascorbic acid, is involved in many biochemical pathways important to exercise metabolism and players' health. [11] Exercise increases oxygen consumption in active muscle fibers compared to the resting state, and superoxide anion production in muscle mitochondria increases during aerobic exercise.[12] There are different theories about the role of vitamin C in preventing oxidative stress after exercise .

Oxidative stress often occurs in muscle tissue exposed to the production of reactive oxygen species. To investigate the redox status of athletes, common oxidative stress markers such as glutathione (GSH) levels should be measured in connection with the antioxidant status, and when the production of free radicals in the body increases, malondialdehyde (MDA) is one of the important indicators of oxidative stress that is measured.[13]

The current study was designed to investigate the effect of exercise on the level of the cortisol hormone and some physiological variables in male sports.

Materials and Methods

The study was conducted on twenty young (19-22 years old) male volunteer students of the College of Physical Education and Sports Sciences at Tikrit University. Cortisol, vitamin C, GSH, and MDA were measured in the serum of male basketball players who were subjected to physical exercise.

Blood samples were taken from each student in the study two times a day, once before physical effort and the other after physical effort. A total of 5 ml of the venous blood samples was drawn 15 min before starting the physical effort. Also, 5 ml of venous blood was drawn 15 min after the end of the exercise, which lasted for 90 minutes. The blood samples were allowed to stand at room temperature for 30 min. Thereafter, it was centrifuged at 3000 rpm for 15 min. The resulting supernatant designated serum was carefully aspirated using a Pasteur pipette into Eppendorf tubes and stored at −20°C until hormonal and biochemical tests were performed. Serum cortisol, vitamin C, GSH, and MDA levels were estimated using the enzyme-linked immunosorbent assay method.

The cortisol concentration was determined using a ready-made measuring kit manufactured by MyBioSource, USA, using ELISA technology. The vitamin C, MDA, and GSH concentrations were estimated using a ready-made measuring kit manufactured by SolarBio Company, China.

Statistical analysis

Statistical analyses were performed using GraphPad Prism 9 (GraphPad Software Inc., San Diego, CA, USA). Data are presented as mean ± standard deviations. Paired and dependent t-tests were used for comparisons between groups. The level of statistical significance was set at $P \leq 0.05$.

Results and Discussion

Exercise can affect different physiological markers and can reduce levels of the stress hormones, such as cortisol. Biochemical and hormonal investigation can assist in monitoring training adaptations or potential oxidative stress caused by training in basketball players.[15] In this study, we measured the cortisol, vitamin C, GSH, and MDA levels in the serum of twenty young male basketball players before and after the exercise to investigate the effect of exercise on these physiological biomarkers.

Cortisol level

Before exercise, the mean ± standard deviation of cortisol level concentration was 50.042±14.613 mcg/dL, and after exercise, this level changed to 39.402±14.546 mcg/dL. Therefore, cortisol values showed a statistically significant decrease after performing the physical effort ($p<0.05$) with a mean difference of 10.64 mcg/dL (Figure 1).

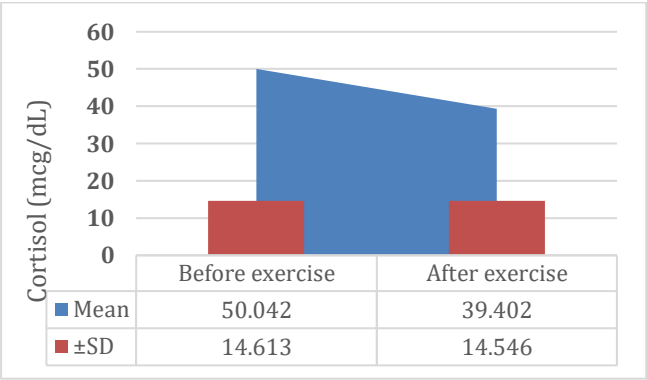

Figure 1. Cortisol level before and after exercise. P-value= 0.026

As mentioned, a training session decreased serum cortisol concentration 10 minutes after the training. The average concentration of this hormone showed a decrease at the end of the exercise compared to the resting state. These results were not consistent with some previous studies.[16-21] This inconsistency can be caused by different factors. In a study on male basketball players, cortisol levels increased after the eight-week training (Büyükyazi *et al.*, 2003). The long period could be a reason for this inconsistency. Roohi (2012) investigated cortisol level changes two hours before and 15 minutes after the basketball game in female players, and the results showed a significant increase in cortisol levels (P<0.05) (Roohi, 2012). However, the experimental condition was different from our study.

Different studies are also found in this field, including the research of Lucia et al., indicating no increase in cortisol in professional athletes with a history.[22] According to this point, exercise as the primary stimulus for cortisol secretion in healthy people who start exercising will have the greatest effect, and gradually over many years, the stimulating effect of exercise will decrease.

Vitamin C level

Before exercise, the mean ± standard deviation of Vitamin C concentration was 7.205±3.131 mg/L, and after exercise, this level changed to 10.703±3.783 mg/L. Therefore, Vitamin C values showed a statistically significant increase after performing the physical effort (p<0.01) with a mean difference of 3.498 mg/L (Figure 2).

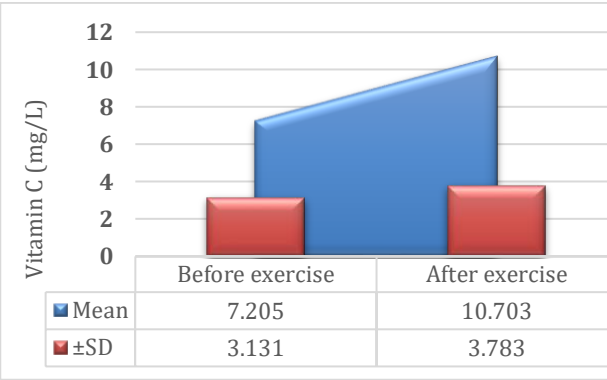

Figure 2. Vitamin C level before and after exercise. P-value= 0.0047

It was found that exercise usually leads to an increase in circulating vitamin C in the hours after exercise (Peake, 2003). As a result, probably with exercise and in response to increased oxidative stress, serum vitamin C increased to prevent oxidative stress after exercise.

GSH level

Before exercise, the mean ± standard deviation of GSH level concentration was 0.115±0.038 ng/ml, and after exercise, this level changed to 0.074±0.035 µmol/L. Therefore, GSH level values showed a statistically significant decrease after performing the physical effort (p<0.01) with a mean difference of 0.041 µmol/L (Figure 3).

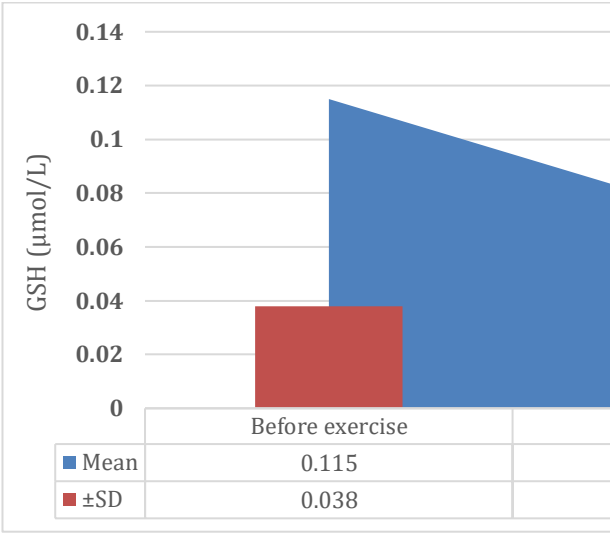

Figure 3. GSH level before and after exercise. P-value= 0.0095

In a study, GSH level as an oxidative stress marker was assessed in basketball players at the start and end of a season. The results showed that GSH levels were decreased in the serum of these players. The results of a study indicated that during light physical exercise, there is low production of reactive oxygen species with low demand for GSH oxidation as an antioxidant defense.

MDA level

Before exercise, the mean ± standard deviation of the MDA level was 0.077±0.022 µmol/L, and after exercise, this level changed to 0.097±0.039 nmol/mL. Therefore, Vitamin C values showed a statistically significant increase after performing the physical effort (p<0.05) with a mean difference of 0.02 nmol/mL (Figure 4).

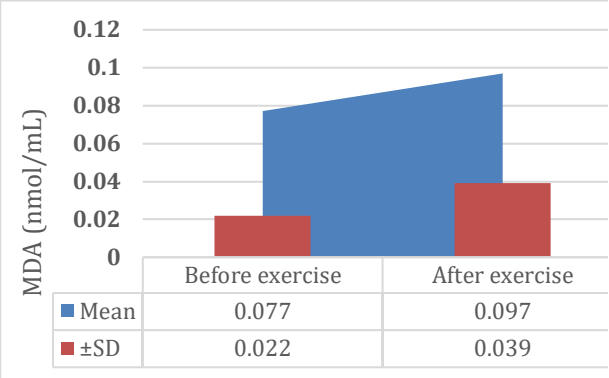

Figure 4. MDA level before and after exercise. P-value= 0.023

Among reactive oxygen species, the hydroxyl radical group causes the oxidation of fats, whose product can be called MDA and is considered an index of oxidative stress. The increase of MDA in the blood of runners and cyclists after exercise has been reported (Ciuti *et al.*, 1996). This enhancement can be caused by increasing lipid peroxidation and production of reactive oxygen species, leading to MDA level enhancement in the serum. A study investigated the influence of exercise on serum MDA levels of soccer players and reported that the level of MDA increased after acute exercise (Kiyici and Kishali, 2012). Another research reported that exercise might increase oxidative stress levels and thus increase MDA levels in individuals.

Conclusion

The cortisol values and GSH levels showed a statistically significant decrease, and vitamin C and MDA levels represented a statistically significant increase after performing the physical effort compared to before training. Exercise in these athletes caused oxidative stress, which increased MDA levels by reducing GSH levels. In addition, it assumed that serum vitamin C increased to prevent oxidative stress after exercise. Also, reducing cortisol levels can be due to these individuals being professional players and having done exercise for years. However, monitoring these biomarkers should be considered to improve the performance and health of basketball players.

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