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Evaluation of the Biochemical and Hormonal Parameters of Athletes

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Abstract

Aim: The aim was to evaluate the biochemical and hormonal parameters of athletes using reference ranges.

Methods: The study sample consisted of 25 male athletes with an average age of 28.50±4.25 (years) who played active professional football in the 2022-2023 season. Basal blood samples were collected 48 hours after the game at rest in the biochemical testing laboratory. The frequency distribution was calculated to determine the distribution of the athletes' biochemical parameters within and outside the normal range. The normal values for each parameter and the high or low deviations from these values were analysed.

Results: According to the results of the study, ALT and AST levels were 28.38±9.86 U/L and 36.69±14.08 U/L, respectively, bilirubin level was 1.12±0.39 mg/dL, iron level was 114.58±34.63 µg/dL, ferritin level was 110.95±110.94 ng/mL, glucose level was 73.62±6.76 mg/dL and the average HDL cholesterol level was 62.47±12.32 mg/dL, the total cholesterol level 178.58±23.97 mg/dL, the LDL cholesterol level 109.49±19.10 mg/dL, the vitamin B12 level 575.15±251.55 pg/mL, the transferrin level 2.36±0.27 g/L and the thyroglobulin level 103.94±473.45 µg/L.

Conclusion: It was found that ALT, AST, ferritin, bilurubin, iron, glucose, HDL cholesterol, vitamin B12, transferrin and thyroglobulin levels were within the reference range and normal range in a large proportion of athletes, but LDL cholesterol levels were too high in 50% of athletes and total cholesterol levels were too high in 11.5% of athletes.

Keywords

Biochemistry, Hormone, Football.

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Sporcuların Biyokimyasal ve Hormonal Parametrelerinin Değerlendirilmesi

Özet

Amaç: Sporcuların biyokimyasal ve hormonel parametrelerinin referans aralıklarına göre değerlendirilmesi amaçlanmıştır.

Metot: Araştırmanın örneklemini, 2022-2023 sezonunda aktif profesyonel futbol oynayan yaş ortalamaları 28,50±4,25 (yıl) olan 25 erkek sporcu oluşturmuştur. Müsabaka dönemindeki futbolcuların maçtan 48 saat sonra, dinlenik durumda biyokimyasal test laboratuvarında bazal kan numuneleri alınmıştır. Sporcuların biyokimyasal parametrelerinin, normal aralık içindeki ve dışındaki dağılımlarını belirlemek amacıyla frekans dağılımı hesaplanmıştır. Parametrelerin her biri için normal değerler ve bu değerlerin dışındaki yüksek veya düşük sapmalar analiz edilmiştir.

Bulgular: Çalışma bulgularına göre, ALT ve AST değerleri sırasıyla 28,38±9,86 U/L ve 36,69±14,08 U/L, bilirubin düzeyi 1,12±0,39 mg/dL, demir düzeyi 114,58±34,63 µg/dL, ferritin düzeyi 110,95±110,94 ng/mL, glukoz düzeyi 73,62±6,76 mg/dL olduğu ve ortalama HDL kolesterol düzeyi 62,47±12,32 mg/dL, total kolesterol düzeyi 178,58±23,97 mg/dL, LDL kolesterol düzeyi 109,49±19,10 mg/dL, B12 vitamini düzeyi 575,15±251,55 pg/mL, transferin düzeyi 2,36±0,27 g/L, ve tiroglobulin düzeyi 103,94±473,45 µg/L olduğu belirlenmiştir.

Sonuç: Sporcuların büyük bir oranında ALT, AST, Ferritin, Bilurubin, Demir, Glukoz, HDL kolesterol, B12 vitamini Transferrin, Tiroglobulin değerlerinin referans aralığında ve normal düzeylerde olduğu ancak LDL kolesterol düzeylerinin sporcuların %50'sinde yüksek dağılım gösterdiği ve total kolesterol düzeylerinin de sporcuların % 11,5'inde yüksek değerlerde olduğu tespit edilmiştir.

Anahtar Kelimeler

Biyokimya, Hormon, Futbol.

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INTRODUCTION

Some physiological and metabolic changes occur in the organism as a result of the stress placed on human chemistry by exercise. The most important of these changes are observed in blood parameters (Hazar, 2008; Talaghir et. al., 2018). However, especially in athletes, different intensities and types of exercise can lead to muscle damage that can cause serious injuries. This is manifested by the increase in plasma levels of creatine kinase (CK), myoglobin and lactate dehydrogenase (LDH), which indicate muscle damage (Peake et. al., 2017; Leite et. al., 2023).

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Exercise is a mechanism that influences the activation of important hormones such as somatotropin, adrenaline, noradrenaline, cortisol and insulin (Ferlazzo et. al., 2020). For example, levels of cortisol, growth hormone and the sex hormone testosterone, which control the body's response to stress, increase during exercise, triggering conditions such as the destruction of muscle proteins and tissue regeneration (Hatfield et. al., 2021). As exercise intensity increases, the anaerobic system is activated, leading to an accumulation of lactic acid in the muscle, which is known to be an indicator of exercise intensity (Damayanti et. al., 2022). This increase in lactic acid levels decreases with adequate rest (Rusdiawan et. al., 2020). With the increase in oxidative stress at the cellular level during exercise, the free radicals in the organism also increase and lipid peroxidation occurs in the cell membranes. Accordingly, the body's antioxidant defence mechanisms are activated (Sadiq, 2023).

In addition, physical activity increases glucose uptake and glycogen consumption in the muscle cells. As a result, temporary or chronic insulin resistance may occur if the cells in muscle, fat and liver do not respond to insulin as they should (Takahashi et. al., 2020). In addition, exercise can also have a short-term but serious effect on the immune system (Hamedchaman et. al., 2023). Intense forms of exercise can cause an increase in inflammatory cytokines (IFN-α and IFN-β) and a decrease in the amount of lymphocytes. This can reduce the activation or efficiency of the immune system (Małkowska and Sawczuk, 2023). In line with this information, exercise, when associated with biochemical and hormonal parameters, can show different effects and results depending on its type, frequency and intensity (Cerqueira et. al., 2020). These effects on biochemical parameters peak a few hours after the end of exercise and may take several days to return to the normal range (Koay et al., 2021). In summary, the effects of training on biochemical and hormonal levels are crucial to accurately analyse athletic performance and to monitor and control recovery processes in injuries of different causes (Díaz Martínez et. al., 2022). As the importance of biochemical and hormonal values for athletes' health, athletic performance, recovery, psychosocial and motivational factors is so great, similar studies should be increased (Hermann et. al., 2019).

The aim of this study was to evaluate the biochemical and hormonal parameters of athletes using reference ranges. Based on the knowledge gained in the study, the effect of the physiological structure of football (aerobic and anaerobic energy systems MaxVo2) on biochemical and hormonal parameters in football players will be evaluated.

METHOD

Model of the research

This study was conducted with a full experimental design using quantitative research methods. Prior to the start of the study, athletes who were actively competing were informed about the study, informed about possible risks and questions to be considered, and completed voluntary informed consent forms. athletes were warned not to eat or drink anything at least 3-4 hours before blood collection and were asked to be ready for blood collection at 10:00 am on an empty stomach. All athletes were given the same conditions for the measurement protocol (e.g. same time zone, constant temperature, same biochemical laboratory).

Study group of the research

The study population consisted of 25 male athletes who played active professional football in the 2022-2023 season. Age: 28.50±4.25 (years), height: 179.80±6.01 (cm) and average body weight: 75±3.80 (kg), a total of 26 athletes were included. The study group consisted of individuals who had no medical conditions or disabilities and who voluntarily agreed to participate in the study. Athletes with injuries and complaints were not included in the study.

Data collection tools of the research

Height, Body Weight: Height was measured with a manual stadiometer without shoes, wearing shorts and a T-shirt. Body weight was measured using a Tanita Body Composition Analyzer BC418 device, with the athletes barefoot and wearing thin clothing (Şenel, 2010).

Biochemical and Hormonal Parameters: In the study, the physical and physiological parameters were measured at the Kocaeli Sports and Fitness Centre and the biochemical and hormonal parameters were measured at the biochemical testing laboratory of the private Konak Hospital of Kocaeli. Basal blood

samples were collected by the medical staff with sterile syringes from the brachial artery of the arm in a sitting position after applying a tourniquet with an average of 7 cc. The blood samples were analysed in the hospital laboratories with prepared anticoagulant tubes (Şenel, 2010).

Data analysis of the research

The IBM SPSS 24 package programme was used for the data analysis. Frequencies and average values of the data were collected and analysed. The frequency distribution was calculated to determine the distribution of participants' biochemical parameters within and outside the normal range. The normal values for each parameter and the high or low deviations outside these values were analysed.

FINDINGS

Table 1. Demographic, biochemical and hormonal values of footballers

Parameters n=26	Unit	Mean	S.D.
Age	year	28,50	4,25
Height	cm	179,80	6,02
Body Weight	kg	74,99	3,88
Alt U/L	U/L	28,38	9,86
Ast U/L	U/L	36,69	14,08
Bilirubin	mg/dL	1,11	0,39
Iron	µg/dl	114,57	34,63
Ferritin	ng/ml	110,95	110,94
Glukoz	mg/dl	73,61	6,76
HDL	mg/dl	62,46	12,32
Cholesterol	mg/dl	178,57	23,97
LDL	mg/dl	109,48	19,10
B12	pg/ml	575,15	251,55
Transferrin	g/L	2,36	0,27
Tirogulobin	µg/L	103,94	473,45

Table 1 shows that the mean age of the soccer players was 28.50±4.25 years, the height 179.81±6.02 cm and the body weight 74.99±3.88 kg. The mean ALT and AST levels were 28.38±9.86 U/L and 36.69±14.08 U/L, the bilirubin level was 1.12±0.39 mg/dL, the iron level was 114.58±34.63 µg/dL, the ferritin level was 110.95±110.94 ng/mL and the glucose level was 73.62±6.76 mg/dL. In addition, the average HDL cholesterol level was 62.47±12.32 mg/dL, total cholesterol level 178.58±23.97 mg/dL, LDL cholesterol level 109.49±19.10 mg/dL, vitamin B12 level 575.15±251.55 pg/mL, transferrin level 2.36±0.27 g/L and thyroglobulin level 103.94±473.45 µg/L.

Table 2. Distribution of biochemical and hormonal parameters of soccer players according to reference ıntervals

Variables	Referans Range	n	%
Alt Range	0-55 Normal Range	26	100,0
Ast Range	0-34 Normal Range	13	50,0
	34> High	13	50,0
	Total	26	100,0
Bılrubın Range	0,2-1,2 Normal	15	57,7
	1,2> High	11	42,3
	Total	26	100,0
Demir_Range	59-158 Normal Range	23	88,5
	159> High	3	11,5
	Total	26	100,0
Ferritin Range	22-275 Normal Range	26	100,0
Glukoz Range	70-115 Normal	20	76,9
	70< Low	6	23,1
	Total	26	100,0
Hdl Range	35-60 Normal Range	13	50,0
	60> High	13	50,0
	Total	26	100,0
Cholesterol Range	0-200 Normal Range	23	88,5
	High 200>	3	11,5
	Total	26	100,0
LDL Range	0-130 Normal Range	23	88,5
	131>	3	11,5
	Total	26	100,0
B12 Range	187-883 Normal Range	22	84,6

	884>	4	15,4
	Toplam	26	100,0
Transferin Range	2-3,6 Normal Range	24	92,3
	1,99<	2	7,7
	Total	26	100,0
Tirogulobin Range	3.5-77.0 Normal Range	22	84,6
	3,4<	3	11,5
	78>	1	3,8
	Total	26	100,0

In Table 2, ALT and ferritin levels were found to be in the normal range in all participants (100%), while 50% of AST levels were normal and 50% were high. For bilirubin level, 57.7% of the participants had normal levels and 42.3% had high levels. iron levels were normal in 88.5% and elevated in 11.5%. For glucose levels, 76.9% of participants had normal levels and 23.1% had low levels. For HDL cholesterol and LDL cholesterol, a distribution of 50% normal and 50% high was found in both groups. For total cholesterol levels, 88.5% were normal and 11.5% were high. Vitamin B12 levels were normal in 84.6% and elevated in 15.4%. Transferrin levels were normal in 92.3% and low in 7.7%; thyroglobulin levels were normal in 84.6%, low in 11.5% and high in 3.8%.

DISCUSSION

Movement is an important phenomenon that activates interrelated physiological processes that regulate balance in the organism. These processes are of great importance for improving athletic performance and shortening recovery time after exercise. The biochemical and hormonal effects of exercise can vary depending on factors such as type of exercise, intensity, frequency and individual differences (Sarıakçalı et. al., 2020; Sarıakçalı et. al., 2022; Küçük et al., 2024).

The effects of high-intensity intermittent and continuous training on the activation of some enzymes in the organism have been the subject of numerous studies in recent years (Taş et al., 2019). In particular, when considered as metabolic feedback of the organism, exercise leads to serious changes in energy production and energy consumption. During exercise, muscle glycogen stores are depleted and energy is required, preparing the environment for the mobilization of glucose and free fatty acids. While a short-term increase in blood glucose levels is observed in athletes, hypoglycemia can occur as plasma glucose levels drop more than usual with increasing exercise duration. In addition, the accumulation of lactic acid is an important biochemical response to intense exercise. Some biochemical parameters have been reported to peak 1-5 days after exercise (Akyüz, 2011). As a result, muscle fatigue occurs, which requires serious recovery after exercise. Biochemical and hormonal levels of athletes within normal ranges have a direct impact on important phenomena such as athletic performance, injury risk, psychological readiness and the effective recovery process. Given such a wide-ranging and important impact of exercise on biochemical and hormonal levels, our study evaluated some biochemical and hormonal parameters of athletes against reference ranges. Our study involved 25 elite male athletes who were actively playing professional soccer in the 2022-2023 season and who volunteered to participate. The average age of the athletes participating in the study was 28.5±4.2 (years), the average height was 179.8±6.01 (cm) and the average body weight was 75±3.8 (kg). According to the results of the statistical analysis in Table 1, the athletes' mean ALT and AST levels were 28.38±9.86 U/L and 36.69±14.08 U/L, respectively, bilirubin level was 1.12±0.39 mg/dL, iron level was 114.58±34.63 µg/dL, ferritin level was 110.95±110.94 ng/mL, and glucose level was 73.62±6.76 mg/dL. In addition, the average HDL cholesterol level was 62.47±12.32 mg/dL, the total cholesterol level 178.58±23.97 mg/dL, the LDL cholesterol level 109.49±19.10 mg/dL, the vitamin B12 level 575.15±251.55 pg/mL, the transferrin level 2.36±0.27 g/L and the thyroglobulin level 103.94±473.45 µg/L.

When evaluating how the athletes' biochemical values were distributed according to the reference ranges, it was found that ALT and ferritin levels were within the normal range (100%) in all participants, 50 % of AST levels were normal and 50% were high. Turğut and Sarıkaya (2020) showed that 8 weeks of calisthenic training showed a significant difference in liver enzymes (AST, ALT) along with some hormonal parameters in sedentary men. Similarly, Sarıakçalı et al. (2021) showed in their study with 28 male participants that the AST enzyme value of the study group consisting of 14 people was significantly different from that of the control group after 4 weeks of training. In another study, Kaynar et. al., (2016) found a statistically significant increase in serum AST, ALT, ALP and GGT

enzyme activities and serum total cholesterol, HDL-C and LDL-C levels after exercise. In this context, we can say that these results from our study are consistent with the literature. Since the AST enzyme is found in the heart, muscle tissue and liver, it increases due to damage to the heart and skeletal muscles in cases such as excessive obesity, weight gain and unbalanced diet caused by a sedentary lifestyle (Bilici & Genç, 2020). In our study, we believe that the fact that 50% of the athletes had high AST enzyme levels and 50% were in the normal range is due to the fact that they were actively training and eating a regular diet accordingly. The results of our study show that 57.7% of the athletes had normal bilirubin levels and 42.3% had high bilirubin levels. We believe that the fact that the athletes' bilurubin levels are within the normal reference range and at an appropriate level is due to the fact that they exercise regularly. Similar to our study, Swift et. al., (2012) found that aerobic exercise at various doses improved participants' bilirubin levels. The athletes' iron levels were normal in 88.5 % and high in 11.5 %. Kocahan et. al., (2021) concluded in their study of adolescent male athletes that creatinine, urea and blood urea nitrogen levels as well as sodium, potassium, phosphorus, chlorine, magnesium, calcium and iron levels were significantly affected in the training group. This supports our study regarding the positive effect of exercise on iron levels. For another parameter, glucose levels, 76.9% of the athletes had normal levels and 23.1% had low levels. These results show that the glucose levels of most athletes are within the reference range. This situation is thought to be due to the fact that regular training lowers blood glucose levels to the desired level, but the situation in the athletes with low glucose levels could also be related to their dietary profile. In line with this information, Pourtaghi et. al., (2021) showed that the mean values of triglyceride, total cholesterol, high density lipoprotein, low density lipoprotein and fasting blood glucose decreased significantly after regular physical activity.

For HDL cholesterol and LDL cholesterol levels, a distribution of 50% normal and 50% high was observed in both groups. For total cholesterol levels, 88.5% were normal and 11.5% were elevated. As a significant indicator of heart health, the HDL levels of the majority of athletes were in the normal range, while the levels of the other half were classified as high. Çolak et. al., (2003) found an increase in HDL-C levels and a decrease in LDL-C levels in people with regular physical activity. Similarly, Bernstein et. al., (2002) found that high-intensity exercise increased HDL-C levels due to interaction with ApoE4 in the blood. The vitamin B12 levels of the athletes were normal in 84.6% and high in 15.4%. According to the results of our study, 92.3% of the athletes had normal transferrin levels and 7.7% had low transferrin levels. Since almost all of the iron in the blood is transported by transferrin, the amount of TIC (total iron binding capacity) also reflects the amount of transferrin. The serum transferrin level and thus also the TIC is increased during pregnancy, when taking the pill and in the case of Fe (iron) deficiency (over 400 µg/dl). It decreases in chronic inflammation (such as infections, malignancy) (Beşışık, 2003). In accordance with this information, it is important to increase the appropriate amount of transferrin in the blood, and in our study and in the literature, exercise was found to be effective in this situation (Malczewska et. al., 2000; Ziolkowski et. al., 2014).

Thyroglobulin (Tg) is a glycoprotein synthesized in the thyroid gland and is essential for the production of thyroid hormones. Measurement of thyroglobulin levels is a specific biomarker for the thyroid gland. The serum Tg level therefore provides information about the status of normal or tumoral thyroid tissue. Therefore, Tg measurements are very important in the follow-up of thyroid cancers (Emerk, 2006; Giovanella et. al., 2014; Şekeroğlu et. al., 2019). In our study, 84.6% of the thyroglobulin levels of athletes were found to be normal, 11.5% low and 3.8% high. It is based on the scientific fact that regular and strenuous exercise provides a powerful preventive treatment against cancer and has the potential to reduce the incidence level by 40% (Newton & Galvão, 2008). In this context, we can say that almost all of the athletes had a normal functioning thyroid gland and their cancer risk was significantly lower than that of other athletes.

CONCLUSION

The examination of our study and the existing studies showed that the values for ALT, AST, ferritin, bilurubin, iron, glucose, HDL cholesterol, vitamin B12, transferrin and thyroglobulin were within the reference range and normal in the majority of athletes. Only the LDL cholesterol levels were normal in 50% of the athletes and high in 50% of the athletes. In addition, 11.5 of the athletes were found to have high total cholesterol levels. In line with this information, the effects of training on biochemical and hormonal levels vary depending on individual physiological characteristics and training routine. Personalized training programs should be designed with individual differences in mind and supported

by appropriate dietary routines. In light of this information, the determination of reference ranges for biochemical and hormonal values plays an important role in monitoring the health profile of athletes and interpreting athletic performance. On the other hand, excessive training or insufficient recovery time can cause a decline in anabolic hormones. This can lead to long-term chronic fatigue and persistent poor performance.

RECOMMENDATIONS

- In further research, correlations between acute and chronic training can be investigated.
- Biochemical parameters and enzymes in soccer players can be compared.
- Biochemical parameters and fatigue indices can be compared with soccer players in different leagues.

Ethical Approval Permission Information
Ethics Committee: Manisa Celal Bayar University Faculty of Medicine Health Sciences Ethics Committee
Division / Protocol No: 20.478.486/1606

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