Original article

Seasonal change of some biochemical parameters of athletes attending school sports

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Abstract. *Objective:* Workouts affect the biochemistry of the organism significantly. Liver enzymes and lipids are important biochemical markers that affect the performance of athletes along with the training. The purpose of this study is to determine the effect of training sessions of athletes participating in school sports on liver enzymes and lipid metabolism during competitions. *Method:* The research group consists of 16 male volunteer athletes between 12-14 years of age. Athletes participating in the research trained for competitions according a program that lasts three months for 60 minutes per day three times in a week and one day for workouts in each week. Blood samples were taken twice before the school sports competitions started and at the end of the competitions. In the blood samples, liver enzyme values and lipid levels were determined. The data obtained were analyzed using SPSS 22 package program. *Findings:* In consequence of the analyzes, the differences in the levels of Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), C-reactive protein (CRP) and Lactate dehydrogenase (LDH) were detected in the liver enzymes of the athletes participating in the study (p <0,05), whereas Gama-Glutamil Transferase (GGT), Alkaline Phosphatase, serum bilirubin total and bilirubin direct concentration levels were not statistically differentiated in the pre-posttest results (p> 0,05). A significant decrease was observed in the lipid values of the athletes in general as a result of the training performed and cholesterol, triglyceride, LDL and HDL values were found to differ significantly in the pre-post test results (p <0,05). *Conclusion:* As a result, it has been determined that long and regular training sessions have a positive effect on athlete's liver enzyme levels and lipid metabolism. In this context, we think that performing performance measurements in athletes using physiological and biological parameters will positively affect the health and performance of athletes.

Keywords: Lipid, Liver Enzymes, Training, Performance

Introduction

Changing living conditions with the developing technology in recent years have also caused some changes in the field of sports, as in all areas of society. Along with these changes, the coaches have redesigned the training in cooperation with the scientists by looking at the results of the training and the results of the tests performed in order to increase or maintain the performance of the athletes. All these innovative studies are aimed at maximizing the performance of athletes, protecting them, achieving success and protecting their health (1,2). In this context, all these studies create some biochemical changes in the organism according to the physical condition, age, gender, nutritional status of the athletes as well as the duration, frequency and intensity of the exercises done (3).

The effect of acute or chronic training on biochemical parameters in the organism is known, and the general opinion is that regular training programs have a positive effect on liver enzymes and lipid levels (4,5,6,7,8). Long-term training causes some changes in the organism related cellular in muscle, cardiovascular system, body stokin levels, liver enzymes and lipid metabolism (9,10).

The liver has many functions besides red blood cells and hormone production, glycogen storage, synthesis of plasma and proteins. Many enzymes are produced, stored, released, condensed in liver cells (hepatocytes) and released into the blood in case of damage. The first indicators of liver damage are AST, ALT, GGT, LDH, ALP, CRP enzymes released from these cells. Increases in liver enzyme levels are observed with high intensity and excessive training (11,12,13,14).

The effect of regular training on lipids remains attractive for researchers. The general belief is that the physical activities and training practices affect carbohydrate and lipid metabolism positively. In general, training designed with the current conditions of athletes decreased in plasma lipid levels such as total cholesterol, low-density lipoprotein-cholesterol (LDL-C) and triglyceride (TG), and increases in high-density lipoprotein-cholesterol (HDL-C) levels (15,16,1718,19,20,21,22).

In addition to sports competitions and training, one of the factors determining the performance of athletes is biological responses. The importance of biological factors in the performance of the athletes enabled the researchers to focus on these issues. In this study, it was investigated to identify the physiological expression of the liver markers and lipid metabolism of the biomarkers that change during the competitions of the athletes participating in school sports.

Material and Method

Research Group

16 male athletes between 12-14 years of age who participated in the sports competitions in schools in Elazig province and continue their training regularly and who do not have any metabolic disorders participated in the study voluntarily. It was carried out to determine the effect of regularly applied training in the research group on liver enzymes and lipid metabolism.

Exercise Program

Considering the competition schedule, the athletes have followed a training program in the athletics branch for a three-month period, three days a week in which one-day fitness-endurance training, ninety minutes per day and they also participated in athletics competitions. Within the scope of the training, sixty-five minutes of exercises were applied to the athletes after the fifteen or twenty minutes of warm-up period in every training unit, and five-minute of cooling exercises (stretching) were performed at the end of the training. Workouts were adjusted according to the fitness level of the study group according to Max 60-65% and applied until the end of the competition calendar, and in the following weeks, the level was increased to Max 65-75%. The intensity of the exercise was designed according to the Karvonen method.

Biochemical Measurements

Before the school sports competitions started, blood samples were taken twice from the athletes forming the research group while resting, before and after the competitions. Athletes participating in the study were constantly observed during the training. Athletes were asked not to take any medications or supplements that would affect the metabolism, they were also asked to eat enough and balanced, pay attention to sleep and rest periods. In order to determine the levels of liver enzyme (ALT, AST, GGT, ALP, LDH, bilirubin) and lipid (cholesterol, triglyceride, HDL, LDL) in the blood samples taken from the athletes pre training and post training, the average 7cc blood samples were taken with sterile injectors by the specialists by applying turnstile to the arm from the vein while athletes resting or sitting. Analysis of blood samples taken was done in a private hospital laboratory using anti-coagulation tubes prepared beforehand.

Data Analysis

The data were analyzed using SPSS 22 package program. The normality test (Kolmogorov-Smirnov) was used to determine whether the data within the group showed a normal distribution or not. After determining that the data showed normal distribution, Paired Samples t test was applied to compare the pre-post test data of the research group. Significance level was taken as p <0,05.

Results

Table 1 shows the total liver enzymes and lipid values. In general, liver enzymes and lipid values of the athletes appear to be within the reference range accepted by the laboratory.

Table 1. Pretest-Posttest Values of Liver Enzymes and Lipid Levels of the Research Group (mean ± s)

	Pre-Test		Post-Test		The reference range
Measurements	$\overline{X}$	**Sd**	$\overline{X}$	**Sd**	
ALT (U/L)	12,75	3,733	11,19	2,738	0–45 U/L
AST (U/L)	23,25	4,568	19,56	3,444	0–35 U/L
CRP (mg/dl)	0,4788	0,232	0,4581	0,222	0–0,5 mg/dl
GGT (U/L)	14,56	1,263	14,88	1,586	2–42 U/L
LDH (U/L)	185,25	3,152	195	6,450	0–248 U/L
ALP (U/L)	92,75	6,658	92,19	5,431	74–390 U/L
Billurubin (Direct) (mg/dL)	0,1825	0,018	0,1788	0,015	0,0–0,2 mg/dL
Billurubin (Total) (mg/dL)	0,6562	0,129	0,6546	0,120	0,3–1,2 mg/dL
Cholesterol(µg/dL)	125,69	39,707	123,31	38,595	110–200 mg/dl
Triglycerid (mg/dL)	70,75	9,808	69,56	9,201	50–200 mg/dl
LDL(µg/dL)	65,25	24,225	62,75	22,579	85–125 mg/dl
HDL(µg/dL)	49,38	7,411	50,81	6,493	40–80 mg/dl

Table 2 shows the total liver enzyme values of the athletes participating in the research. The results of pre-post test of the total liver enzyme values measured were generally among the reference values (Table 3). Serum bilirubin total and bilirubin direct concentration levels are within the reference values and no significant difference was determined in the pre-post test values (p> 0,05). Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), C-reactive protein (CRP) and Lactate dehydrogenase (LDH) values are in the reference range and statistically significant differences were found in the pretest-posttest results (p <0,05). Gamma-Glutamyl Transferase (GGT) and Alkaline Phosphatase levels are in the reference range and no significant difference was found in the pretest-posttest results (p> 0,05).

Table 2. Liver Enzyme Values of the Research Group

	Pre-Test	Post-Test	t	p
ALT (U/L)	12,75±3,733	11,19±2,738	3,180	**0,006***
AST (U/L)	23,25±4,568	19,56±3,444	2,386	**0,031***
CRP (mg/dl)	0,4788±0,232	0,4581±0,222	4,477	**0,000***
GGT (U/L)	14,56±1,263	14,88±1,586	-0,924	0,370
LDH (U/L)	185,25±3,152	195±6,450	-8,327	**0,000***
ALP (U/L)	92,75±6,658	92,19±5,431	0,963	0,351
Billurubin (Direct) (mg/dL)	0,1825±0,018	0,1788±0,015	0,899	0,383
Billurubin (Total) (mg/dL)	0,6562±0,129	0,6546±0,120	1,807	0,091

$^{*}p< 0.05$

Table 3 shows the total lipid values of athletes. The measured lipid values are generally in the reference range. As a result of the trainings performed, a significant decrease was observed in the lipid values of the athletes in general. Cholesterol, triglyceride, LDL and HDL values are in the reference range and a significant difference was found in the pretest-posttest results (p <0,05).

Table 3. Lipid Values of the Research Group

	Pre-Test	Post-Test	t	p
Cholesterol(μg/dL)	125,69±39,707	123,31±38,595	3,760	**0,002***
Triglycerid (mg/dL)	70,75±9,808	69,56±9,201	4,284	**0,001***
LDL (μg/dL)	65,25±24,225	62,75±22,579	4,767	**0,000***
HDL (μg/dL)	49,38±7,411	50,81±6,493	-4,070	**0,001***

$^{*}p< 0.05$

Discussion

The effect of regular and long-term training in adolescents on liver enzymes and lipid profile has not been revealed. This research reveals the changes in liver enzymes and lipid metabolism as a result of regular and long-term training in adolescents.

The Effects on Liver Enzymes

Long-term training is known to affect the cellular metabolism of athletes, trigger oxidative stress, and alter liver enzyme values by creating biochemical and hormonal differences(23,24,25,26).

Bilirubin is a catabolic product of hemoglobin and is an effective lipid antioxidant. It is known that it creates differences in bilirubin levels in the organism according to the scope, intensity and duration of the training practices (27). In our study, serum bilirubin total and bilirubin direct concentration levels decreased with the training. Urbain and friends (2017) stated in their study on adult individuals that there were decreases in the levels of bilirubin (28). Devries and friends (2008) observed in their study that there were decreases in bilirubin levels after 12 weeks of endurance training (29). In a different study, Kratz and friends (2002) reported that bilirubin levels increased after the competition in their study on marathoners (30). Tirabassi and friends (2018) found in their study that marathoners' bilirubin levels increased after the competition (31). As a result of acute training, an increase in the bilirubin level in the blood leads to liver cell damage, but as a result of regular training, a decrease occurs in the level of bilirubin in the blood.

These results may have been resulted from metabolic events occurring in the organism as a result of regular training.

Alanine aminotransferase (ALT) is a cytosis enzyme and is generally liver-specific. Aspartate aminotransferase (AST), on the other hand, is a mitochondrial enzyme in addition to cytoscopic enzyme and is found in liver, striated muscles, brain, pancreas and blood cells. Lactate dehydrogenase (LDH), an enzyme that helps the body in producing energy, is located in the pancreas, kidney, heart, liver, skeletal muscles, blood cells and even the brain. The high levels of liver enzymes; Alanine aminotransferase (ALT), Aspartate aminotransferase (AST) and Lactate dehydrogenase (LDH) are biomarkers that show tissue damage in the organism.It was observed in the results that there was decrease in Alanin aminotransferase (ALT), Lactate dehydrogenase (LDH) and Aspartate aminotransferase (AST) levels as a result of regular training sessions (32). Wu and friends (2004) stated their study in which athletes' hematological and biochemical parameters were evaluated before and after ultra-marathon that there was an increase in ALT, AST and LDH levels after the race, and they also observed decrease in these values after nine days after the race (33). In different studies; Ramos and friends (2013) stated that AST, ALT and LDH levels increased significantly as a result of the exercises performed in the study in which the effect of two different intensity swimming exercises on the symptoms of oxidative stress (34). Chiu and friends (2018) reported increases in ALT, AST, and LDH levels after an acute exercise performed in their study (35). Tsubakihara and friends (2013) stated in their study that there were increases in AST, ALT, LDH values after acute exercise (36). General studies show that acute training increase the markers of liver and tissue damage wheras chronic training decreases the markers of liver and tissue damage. These results are thought to stem from the positive effect of chronic training on the organism.

C-reactive protein (CRP) is the main acute phase protein and is produced only by hepatocytes. CRP is a very sensitive and objective indicator of physical tissue damage, bacterial infection or other inflammatory conditions. The intensity of CRP levels varies according to the intensity and duration of the training (37,38). In our study, it was determined that there was a decrease in C-reactive protein (CRP) level as a result of the training performed. Kim and friends (2010) reported a decrease in the level of C-reactive protein (CRP) after chronic training performed in their study (39). Fedewa and friends (2017) stated that there was a significant decrease in CRP levels as a result of the exercises performed in the research that examines the effect of exercise training on CRP (40). In another study, Devrnja and Matkovi (2018) stated that CRP levels increased acutely in a study that examined the muscle damage markers of a football match (41). Generally, it is seen that CRP levels increase with acute training in the organism and decrease with chronic training. We think that these results are originated from metabolic changes in the organism according to the intensity and scope of the training.

Gamma-Glutamyl Transferase (GGT) is a cell surface glycoprotein, found in the kidneys, biliary tract, heart, brain and liver and is effective in the transfer of amino acids from the cell membrane and glutathione metabolism (42). Alkaline Phosphatase (ALP) is an enzyme that catalyzes the removal of phosphate from various molecules by providing hydrolysis and is effective in the breakdown of proteins and is found in liver, bones, endometrium, intestines, placenta, lungs (43). The rise of ALP and GGT enzymes are markers of problems in the liver, kidneys and bones (44,45). It was determined in our study that there were decreases in Gamma-Glutamyl Transferase (GGT) and Alkaline Phosphatase (ALP) levels as a result of the training performed. In their study, El-Kader and friends (2014) reported that long-term regular exercises had a positive effect on liver enzymes and ALP and GGT levels decreased as a result of the exercises (46). In different studies; Pettersson and friends (2008) stated that levels of ALP and GGT remain between normal values in adult individuals in one-week weight free weight training (47). Bessa and friends (2008) reported that the athletes' ALP and GGT values did not change after a high-intensity acute exercise.48 Machado and friends (2009) stated that there was no change in ALP and GGT levels in athletes after an acute exercise (49). Studies have shown that there are changes in ALP and GGT levels depending on the duration, frequency and intensity of the training. Contrary to acute training, chronic training is thought to minimize the damage that may appear in the organism.

The Effects on Lipoproteins and Lipids

Lipids which are used as metabolic fuel of the organism, besides its usage in training, a regularly working liver metabolism also provide effective use of lipids. Sources of lipids are long-chain fatty acids taken from plasma and fatty acids released from intramuscular triacylglycerol stores under the influence of intramuscular lipases. The accumulation and increase of lipids are the indicators of some disease and problem in the body (50,51). Most circulating lipids are transported in lipoproteins, and lipoproteins are classified as their various amounts of protein, cholesterol, phospholipid and on the other hand Triglycerides are classified as cholesterol, HDL, LDL and triglycerides based on their densities (52). Cholesterol, which is produced in the liver organ, can take place in the structure of lipoproteins and pass into plasma, and can pass into bile by transforming into cholesterol or bile acids without any interaction.It exists as steroid structure and takes place in the structure of many tissues in the organism. While the increase of LDL in the organism causes the formation of atherosclerosis in the vessels by causing accumulation called atheroma, HDL helps the removal of bad cholesterol in the organism and prevents the formation of atherosclerosis in the vessels (53,54). Triglycerides are primarily produced by the intestines and liver, while triglycerides taken by dietary enter the circulation in the chylomicrons, and triglycerides combined with the synthesized fatty acids and lipids returning to the liver are secreted in VLDL (55). In our study, significant increases in HDL levels were observed as a result of the training sessions, while significant decreases were observed in cholesterol, triglyceride and LDL levels. Ramezani and friends, (2017) stated in their study that regular exercises increase HDL levels and decrease cholesterol, LDL and triglyceride levels in children (56) In their study, Pons and friends, (2018) reported an increase in HDL level as a result of 6-week regular training; on the other hand they reported decreases in LDL, cholesterol and triglyceride levels (57). In their study, Çınar and friends, (2018) found that six-week exercise and zinc supplementation positively affected the blood lipid levels of athletes and sedentary individuals (58). In their study, Eichenberger and friends, (2009) stated that after 3-week training, there was an increase in HDL level, a decrease in LDL and triglyceride levels and no change in cholesterol level (59). In their study, Çınar and friends, (2019) determined that the ten-week exercise program positively affected the lipid profile of the participants (60). Välimäki and friends, (2016) found an increase in HDL level and a decrease in LDL level after an acute exercise (61). It was observed that lipid levels in the organism were positively affected by the workouts sessions. It is believed that if the training program to be applied is structured by considering the physical condition of the athletes, it will increase athletic performance and help preventing metabolic disorders in the organism.

As a result; It was determined that training during the competitions has a positive effect on liver enzymes and lipid metabolism of the athletes participating in sports competitions among schools. In consequence of the training, cholesterol, LDL, triglyceride, ALT, AST, bilirubin total and bilirubin direct levels decreased; LDH, GGT and HDL levels increased. With these data we think that if the training sessions to be applied are designed according to the conditions of the athletes, they will affect the performance of the athletes positively and will be affective in preventing the metabolic problems that may occur in the body.

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