The physical fitness and its relationship with some biochemical changes in athletes

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Abstract:
The study began in September 2022 and extended until December 2022. (70) samples of blood serum were collected from athletes in Mosul sport centers, their ages were between (17-40 years). Samples were divided into two groups: One of them is control group and the other is athletes' group. The study included measuring the biochemical parameters of serum for both groups, which included: estimating the concentrations of glucose, urea, uric acid, cholesterol, Tri glyceraldehyde (TG), total protein (TP), albumin, total bilirubin, the activities of alanine aminotransferase (ALT), Aspartate aminotransferase (AST), creatine kinase (CK) enzymes, sodium (Na), potassium (K), chloride (Cl), magnesium (Mg), and calcium (Ca) concentrations. The study showed that there was a significant decreased in the concentration of glucose, cholesterol, TG, TP, albumin, Na, Cl, and in the activities of AST and ALT, while there was a significant increase in the concentration of urea, uric acid, total bilirubin, K, and in the activity of CK enzyme. The concentrations of Mg and Ca gave a non-significant change in athletes group in compared with control group.
Keywords: Athletes, biochemistry, exercise physiology, Physical fitness, Sports performance

اللياقة البدنية وعلاقتها ببعض المتغيرات البايوكيميائية لدى الرياضيين

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الخلاصة:
بدأت الدراسة في شهر سبتمبر 2022 وامتدت حتى شهر ديسمبر 2022. تم جمع (70) عينة من مصل دم الرياضيين ممن يتابعون مراكز الموصل الرياضية، تراوحت أعمارهم بين (17-40 سنة). تم تقسيم العينات إلى مجموعتين: واحدة منهم هي مجموعة االسيطرة والأخرى هي مجموعة الرياضيين. تضمنت الدراسة قياس بعض المتغيرات الكيموحيوية لمصل دم كلا المجموعتين والتي شملت: تقدير تراكيز الكلوكوز واليوريا وحامض اليوريك والكوليستيرول والكليسيرايدات الثلاثية والبروتين الكلي والالبومين والبيليروبين الكلي وكذلك فعالية كل من أنزيمات الألانين امينوترانسفريز والأسبارتيت امينوترانسفريز والكرياتين كاينيز بالاضافة الى تراكيز كل من الصوديوم والبوتاسيوم والكلورايد والمغنيسيوم والكالسيوم. أظهرت الدراسة وجود انخفاضا معنويا في تراكيز كل من الكلوكوز والكوليستيرول والكليسيرايدات الثلاثية والبروتين الكلي والالبومين والصوديوم والكلورايد وفي فعالية كل من انزيمات الألانين امينوترانسفريز والأسبارتيت امينوترانسفريز بينما تبين وجود ارتفاعا معنويا في تراكيز كل من اليوريا وحامض اليوريك والبيليروبين الكلي والبوتاسيوم وفي فعالية انزيم الكرياتين كاينيز. اما تراكيز كل من المغنيسيوم والكالسيوم فلم تظهر تغيرات معنوية لدى مجموعة الرياضيين مقارنة مع مجموعة السيطرة.

الكلمات المفتاحية: الرياضيون، الكيمياء الحيوية، فسيولوجيا التمرين، اللياقة البدنية، الأداء الرياضي

Introduction

Physical fitness is defined as a person's capacity to do physical activities and tasks successfully, with enough vigour, alertness, endurance, flexibility, and coordination to enjoy leisure activities and meet unforeseen emergencies. Physical exercise has significant public health consequences because it has been linked to a number of illnesses such as obesity, diabetes, coronary artery disease, and depression. Active healthy living helps both individuals and society in a variety of ways, including increased productivity, improved morale, lower absenteeism, and lower health-care expenses. It also enhances psychological well-being, physical ability, self-esteem, and stress management (Nida *et al.*, 2023).

Sedentary habits, physical exercise, and obesity can all have an impact on physical fitness. Obesity has resulted in a loss in physical exercise capability as well as a decline in health-related fitness, notably cardiorespiratory fitness and movement speed (Grasdalsmoen *et al.*, 2020).

Physical exercise and training on a regular basis cause physiological and metabolic adaptations; the systems and all organs are affected, and such adjustments are linked to performance in sports (Angel *et al.*, 2022). Some biomarkers in blood have been presented as suitable indicators for identifying short and long-term training effects, as well as for preserving identifying chronic stress, health, weariness, inflammation, or as a means of avoiding damage (Campbell and Turner, 2018). Athletes often undertake analytical tests that include biochemical parameters as a health check control in order to ensure optimal level of health and the absence of any aberration that may affect exercise performance. Continuous and intensive exercise, training, and contests, on the other hand, can cause alterations in numerous blood parameters that should not be regarded as abnormal but as exercise-induced (Lombardo *et al.*, 2019).

Biochemical indicator screening and regular monitoring of the parameters is a common process in exercise physiology and sports medicine. Several recent studies have evaluated the athletes' clinical utility of screening parameters, but no studies have been conducted to date to evaluate the screening for other biochemical markers in clinical practice (Fallon,2008).

The evaluation of the athlete will begin, first of all, to evaluate the health to diagnose situations that contraindicate and/or restrict training or competition, and, in the second place, to determine objectively the functional abilities to prescribe and plan a training process (Urdampilleta *et al.*, 2014).

Many writers have proposed comprehensive screening in order to develop a numbers of standard ranges for athletes, and these intervals reference are becoming available (Lippi *et al.*, 2004 ; Lippi *et al.*, 2006). Others have proposed that screening some biochemical markers while athletes are resting could serve as a baseline for biochemical monitoring of training (Petibois *et al.*,

2003) and others propose that such monitoring could help predict the onset of overtraining (Hartmann and Mester, 2000). Each of these are wonderful goals, but because

biochemical monitoring is very expensive, causes discomfort, and is unpleasant, each of these potential applications must be proved to be worthwhile, as well as any clinical application of biochemical screening must be established.

The study's objectives

The goal of this study was to analyse physical fitness and its relationship to some biochemical variables in athletes.

Material and methods

Sample collection and preparation:

The (35) fasting blood samples were collected from athletes' men in Ninavah sport centers, their ages are (18-40 years) and (35) samples within the same age as a control group.

Preparation of serum samples:

Blood serum samples were collected as stated by instructions of the World Health Organization, as venous blood was drawn from patients and healthy people after sterilization of the area using alcohol sterilizers or Hepatin, then blood samples were placed in plastic tubes and left until the blood clotted for 15 minutes when 37 °C, then placed in a centrifuge for 4 minutes at a speed of 4000 rpm, and the serum was collected in plastic tubes, and the samples were frozen at -20 °C until It is used to measure biochemical variables.

Estimation of biochemical parameters measured in serum:

Determination of glucose was executed by enzymatic oxidase-peroxidase method according to (Burits and Ashwood, 2006) as modified by Randox Laboratories.

The urea was estimated according to the enzymatic method using standard kits from Randox, UK.

Uric acid level was estimated by using the Uricase enzymatic methods of (Burits and Ashwood,2006) using manufactured kit by Biomerieux.

The cholesterol and TG levels were estimated using ready-made solutions Kit from the Italian-born company Giesse Diagenostics and using the Smart 150 device (Chemistry Autoanalyzer).

The TP concentration was measured using the Biuret method, and using a Standard Kit from the French company Biolabo (Burits and Ashwood,2006).

The albumin concentration was estimated using the Bromocresol Green

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method, according to the method used by (Rodkey)in 1965, as it used a standard kit from the French company Biolabo (Burits and Ashwood,2006).

The concentration of total bilirubin was estimated using ready-made solutions kit from the French Biolabo company, and the method depends on the interaction between bilirubin with the diazotized Sulfalinic acid reagent in order to form the coloured compound Azobilirubin (Walters and Gerarde, 1970).

The activities of both ALT and AST in blood serum were estimated using a standard kit produced by French Biolabo company (Burits and Ashwood, 2006).

CK activity was measured in serum using Cobas c111 chemistry apparatus, German origin, (Szasz *et al*.,1976).

The concentration of Na, K and Cl was measured by using a chemistry device (Abbott auto analyzer instrument) from ARCHITECT, the American company.

Mg was determined by colorimetric method using manufactured kit by Syrbio (Pesce and Kaplan, 1987).

The concentration of Ca was determined by using a standard kit from the French company Biolabo according to the method (Burits and Ashwood, 2006).

Statistical analysis:

The statistical program SPSS (version 21) was used to statistically analyse the study data and the complete randomized design (CRD) was followed by the one-way analysis of variance. The averages were used for the study data that included more than two variables, and the standard error SE was used for the study criteria mentioned previously, while Duncan's multiple range test was used (Duncan, 1955) to compare the means at the level of significance $P \leq 0.05$, and the t-test via the independent t-test was used to compare the study criteria included in the statistical analysis which includes two variables.

Results and discussion

Because the scientific support for biochemical processes. monitoring during exercise using the settings parameters included in this study is limited, and there are no established biological indicators of excessive training, it appears that biochemical screening of athletes is only appropriate in studies that seek to establish reference periods for particular athletic groups. The biochemical parameters urea, uric acid, albumin, and total bilirubin showed a highly increased of athletes group compared to those for control group, whereas other analyses cholesterol, TG, and TP, showed a significant decreased in athletes' group in comparison to the control group, as seen in Table 1.

Data for serum glucose levels revealed a small drop-in athlete group as compared to the control group at a probability value $P \leq 0.01$. Similarly, Lippi *et* *al*., discovered a drop in glucose levels among elite skiers and cyclists when compared to male sedentary healthy control group (Lippi *et al*., 2004). Degreased serum glucose levels in athletes may be caused by improved metabolic regulation, notably increased tolerance to glucose and insulin sensitivity, both of which are common markers of regular aerobic physical activity (Angel *et al*., 2022). Exercise increases the sensitivity of plasma glucocorticoid. During exercise, its level rises with increasing exercise volume, modifying the body's adaptation to the external environment, which is not helpful to post-exercise rehabilitation. Blood glucose levels fluctuate in response to emotional stress, injury, weariness, disease, and high-intensity exercise (Dongsheng and Hui, 2021). Serum glucocorticoids are stress hormones that are rapidly generated by the body. In this study we found that athletes' total sugar levels in serum were within the normal range for ordinary athletes.

Table 1: levels of some biochemical changes in serum of athletes groupcompared to control group

Parameters	Mean ± SE		P-value
	Athletes group	Control group	
Glucose mmol/L	3.76 ± 0.95	5.00 ± 0.99	P ≤ 0.01
Urea mmol/L	7.16 ± 1.05	5.70 ± 0.91	P ≤ 0.01
Uric acid mmol/L	0.35 ± 0.02	0.31 ± 0.03	P ≤ 0.05
Cholesterol mmol/L	4.80 ± 0.88	5.17 ± 0.59	P ≤ 0.01
T.G mmol/L	1.02 ± 0.05	1.69 ± 0.99	P ≤ 0.05
T. protein g/L	72.50 ± 4.75	74.50 ± 3.82	P ≤ 0.01
Albumin g/L	43.00 ± 2.73	46.50 ± 2.87	P ≤ 0.01
T. bilirubin µmol/L	15.39 ± 1.52	12.83 ± 1.03	P ≤ 0.01

Increase serum urea concentration was knower in athletes' group when compared with control group. Following exercise, this parameter increases are very clearly reported (Clarkson *et al*., 2006). They are hypothesised to represent elevations in output as a result of amino acid breakdown caused by muscle cell deterioration. additional elements related to sports, additional elements increased amino acid consumption as well as dehydration, may also cause an increase in serum urea. Serum urea and other biomarkers are also used to track the impact of training. (Nunes *et al*., 2012). Urea is a byproduct of breakdown of protein nitrogenous compounds, and it is produced in liver and expelled by kidneys. Urea levels in blood have been utilized as to assess protein catabolism and to stimulate gluconeogenesis with increased training loads. Urea nitrogen concentrations may reflect total protein synthesis vs breakdown (Romero-Parra *et al.*, 2020). The increment of urea nitrogen levels could be caused by catabolism, severe exercise training, and a high dietary protein intake.

Some trainers and doctors utilize urea levels and CK activity to evaluate the intensity and exercise volume (duration). Monitoring serum urea concentrations and CK activity may suggest an acute reduction in tolerance of exercise, according to one theory (Nunes *et al.*, 2012).

Final metabolite of purine nucleotide is uric acid, the latter of which is utilized for muscle contraction during exercise. At $P \leq 0.05$, this study found an increase in uric acid concentration in the athletes' group when compared to the control group. Athletes and physically active people have higher uric acid levels in their blood, indicating an increased antioxidant ability. Nunes *et al.*, discovered that athletes have slightly higher serum uric acid levels (0.24-0.49 mmol/L) than sedentary people (0.23-0.47 mmol/L), this variation may be accounted by the subjects' training intensity. Elite skiers and cyclists, on the other hand,
exhibited reduced mean serum uric acid levels as compared to male sedentary healthy controls (Nunes *et al.*, 2012). However, there was a drop in uric acid levels discovered in male idle healthy controls versus professional skiers and cyclists. However, as compared to male sedentary healthy controls, elite skiers and cyclists had a lower mean serum uric acid value (Lippi *et al.*, 2004).

The results of cholesterol concentration were shown in Table 1 which indicated that a significant decreased in cholesterol level in athletes' group was noted when compared with control group, this result was agreement with other study of (Steven *et al.*, 2014) which they discovered that there is a definite correlation between persistently increased cholesterol levels (dyslipidaemia) and coronary heart disease. Total cholesterol reduction was regarded to be the gold standard in cardiovascular prevention. Changes in lipid metabolism generated by moderate exercise training have beneficial effects on the cardiovascular system, although the mechanisms behind the protective effects of exercise are yet unknown (Antonella *et al.*, 2020).

Table 1 indicated that the triglycerides was significantly decrease at $p \leq 0.05$. this will be comfortable with (Otegui *et al.*, 2014). Fats are transported in the blood in the form of lipoproteins and triglycerides. The hyperglycaemic hormones released during exercise (adrenaline, norepinephrine, cortisol and hormonal agents) allow for accelerating the use of TG through lipolysis (passing fatty acids into the blood), without increasing acidity and free fat and thus increasing the use during exercise. Taking into account oxidation. There is a relationship between the use of free fatty acids and carbon dioxide during exercise depending on the type of diet achieved before exercise or the glycaemic index of the previous diet.

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It has been observed that diets containing high levels of carbon dioxide before physical activities can increase carbon dioxide utilization and vice versa.
On the other hand, depending on the intensity of the exercise performed and the greater or lesser use of fat as energy fuel, you can modify some lipid parameters, especially in blood triglycerides, with a tendency to decrease in children, and in a long period. Permanent resistance, due to the activity of the main lipoprotein in skeletal muscle.

In our study, the TP and albumin values were narrower than in the control group. Furthermore, when comparison to healthy male sedentary controls, elite skiers and cyclists had a slight drop in serum albumin mean value. (Lippi *et al.*, 2004). Also, our result was agreement with (Ana *et al.*, 2022) which they indicated that the albumin levels was droped in athletes group compared with healthy control group.
A mismatch of relationship between dietary protein consumption and dietary protein requirements can result in net protein loss in athletes. A combination of indicators such as TP, albumin, and urea may assist athletes in determining their protein status and making dietary changes to optimize training results. Although the method by which these two markers are related is uncertain, albumin has been linked to human growth hormone levels in the blood. In the absence of sickness, low albumin, low blood protein, and excessive urea levels in athletes may suggest a lack of protein consumption (Romero-Parra *et al.*, 2020).

Physical activity induces hemolysis and rhabdomyolysis, which can raise serum total bilirubin levels. The results of this study showed that serum total bilirubin levels were higher in the athletes group compared to the control group, which is consistent with earlier studies. (Díaz-Martínez, 2017).
The main cause of elevated blood bilirubin in athletes is hemolysis followed by hemoglobin degradation. There was a substantial amount describing red cell hemolysis following different kinds of exercise. While one hour of activity at 75% maximum oxygen uptake may elicit some exercise-induced hydrolysis, Lombardo *et al.* found that trauma associated with foot strike is the major contributor to hydrolysis during running (Lombardo *et al.*, 2019). Furthermore, we discovered increases in serum total bilirubin concentrations in bruising caused by conflict or defense systems causes concentrations in combat sports (boxing, karate, and judo) and team sports (handball and basketball). due to bruising produced by conflict or defense systems.

Aminotransferases (AST or GOT and ALT or GPT): In addition to their liver enzymes, they are associated with muscle activity. In the field of physical and external exercise, the conversion of amino acids into ketoacids through an aminotransferase reaction allows degradable functions: first incorporation of ketoacids into glucose catabolic pathways (glycolysis and Krebs cycle) and second conversion of ketoacids from gluconeogenic amino acid. To glucose, as happens in the case of alanine (which is the most important amino acid in gluconeogenesis in cases of glucose deficiency). Health, which is a vital organ of energy exchange and performs multiple detoxifying functions, is clearly affected by the impact of

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physical activity. The main liver change observed in an individual who has exercised is an increase in transaminases. The enzyme which all studies follow is most clearly modified by AST, although it is found in many other organs, it is not at first used to distinguish the origin of its action, being muscular or hepatic. ALT is more specific for indicating liver damage, undergoes modifications with minor physical exertion and is always accompanied by increased AST and CK (Harrington, 2000).

Although exercise alters the dynamics of these enzymes after exercise, it does not counteract strenuous exercise causes major alterations in liver function. In the distance and especially in long-term resistance, it greatly increases AST and ALT, and some other literature suggests that you can also use potential indicators of muscle catabolism that are more specific than CK (Mena *et al.*, 1988). In super entrainment syndrome, transaminases are also significantly increased. Adaptation that occurs with training has been shown to result in greater release of enzymes, which leads to reduced permeability of the muscle cell membrane.

Table 2: levels of some enzyme activities in serum of athletes group compared to control group

Parameters	Mean ± SE		P-value
	Athletes group	Control group	
AST U/L	43.51 ± 3.87	50.14 ± 2.76	$P \leq 0.01$
ALT U/L	33.50 ± 2.95	35.24 ± 2.54	$P \leq 0.05$
CK U/L	781.71 ± 19.86	225.01 ± 13.66	$P \leq 0.001$

Our results were contrary to what described by (Noakes, 1987) as shown in Table 2, Previous research has shown that activities as diverse as walking can cause an increase in AST. Boxing competition, swimming, rowing, and calisthenics on a treadmill for five minutes. Increases in AST activity in elite training athletes, especially when related with elevated in CK activity, normal other liver function tests, as well as absence of signs and clinical symptoms, appear to be of no clinical relevance. Because ALT shown increased in response to exercise, an increase in the activity of this enzyme combined with a small elevation in AST activity which is almost definitely insignificant. The biggest range in values was discovered in the control group of CK activity as shown in

Table 2. Physical activity produces rhabdomyolysis, which is the release of the contents of muscular cell, as well as an increase in activity of skeletal muscle enzyme CK in serum, which is an indicator of tissue damage after acute or chronic injuries (Nunes *et al.*, 2011). Total CK levels are affected by race, age, physical activity, muscle mass, and weather. Its clearance from plasma is affected by training level, kind, and intensity, and moreover exercise duration (Angel *et al.*, 2022).

The activity of CK varies greatly, including individual differences in CK response to hazardous exercise. Furthermore, the activity of serum CK was evaluated within persons who exercised to a same degree revealed a large degree of variability. In our investigation, CK had significantly higher levels than the control group, which was consistent with previously published material. (Mougios, 2007).

Serum sodium concentrations were significantly decreased in the athletes' group than in control group at $P \leq 0.05$, although potassium concentrations were higher in the athletes' group than in control group. Table 3 shows that the athletes' chloride readings decreased as compared to control group.

Calcium and magnesium showed a non-significantly changes in athletes' group when compared to control group as indicated in Table 3. Magnesium is a common element that is essential in many biological functions. Magnesium is required as a cofactor in over 300 metabolic processes. Rhabdomyolysis and consumption of magnesium-containing drugs such as anti-acids, vitamins, or cathartics are two sports-related causes of hypermagnesemia. Hypermagnesemia is less common than hypomagnesemia. Hypomagnesemia in athletes may be induced by increased sweating when training. Within 24 hours of activity, magnesium levels return to normal (Malliaropoulos *et al.*, 2013 ; Díaz-Martínez, 2017).

Table 3: levels of some ions concentration in serum of athletes compared to control group

Parameters	Mean ± SE		P-value
	Athletes group	Control group	
Na mmol/L	139.01 ± 10.74	141.05 ± 11.36	P ≤ 0.05
K mmol/L	4.65 ± 0.98	4.31 ± 0.72	P ≤ 0.05

Cl mmol/L	103.25 ± 9.76	105.98 ± 8.99	$P \leq 0.05$
Mg mmol/L	0.86 ± 0.06	0.87 ± 0.02	NS
Ca mmol/L	2.45 ± 0.56	2.42 ± 0.45	NS

Conclusion

Because the values for the control group aren't relevant for athletes, new reference ranges for biochemical parameters in athletes' players, who's nutritional, hydration, and fasting condition are hard to quantify and are likely to differ from the general non-athletic population, should be established.

In this study, we suggest a range of baseline values to be utilised in the clinical laboratory for clinical report validation. Using these data on value fluctuation, we may compare the latest result to previous findings and check whether the discovered variation is due to analytical and biological factors or if additional factors are involved. Values that exceed the specified limits should be examined, and if proven, specialists should be notified to watch the athlete.

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