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## The effect of synchronized training on enzymes (LDH-CPK) and skill performance in football among ages 17-19

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### Abstract

The aim of this research is to investigate the effect of concurrent training exercises on the enzyme levels (LDH-CPK) and skill performance in football players aged 17-19 years. The researcher utilized an experimental method with two groups: an experimental group and a control group, suitable for the nature of the problem. The research population was selected from football players in various clubs of Wasit Governorate, including Al-Kut, Al-Jihad, Al-Izza, Al-Shuhada, Al-Sharqiya, Al-Nahrain, and Wasit, for the sports season 2022-2023, with a total of 126 players. The research sample was purposively selected from Al-Shuhada Club and Wasit Club in the youth category, considering their suitability for the research requirements. The final sample size was 32 players after excluding goalkeepers and some players from each club due to their incomplete commitment to the training sessions. The sample was further divided into two groups: an experimental group consisting of youth players from Al-Shuhada Club and a control group consisting of youth players from Wasit Club, with each group comprising 10 players. The researchers concluded that concurrent training method contributed to increased levels of enzymes (CPK, LDH) and skill performance in football as compared to pre-measurements. Moreover, concurrent training method is an ideal training approach for the youth category as it has a positive impact on the development of the research sample.

**Keywords:** Synchronized training, enzymes (LDH-CPK), skill performance

### Introduction

Sports training is a planned process based on scientific principles aimed at enabling players to reach higher levels by improving their physical, skill-related, tactical, and physiological abilities, which play a crucial role. Therefore, researchers strive to find the best training methods that lead to achieving these goals, including the method of synchronized training according to its specificity.

Working with synchronized training can lead to biochemical changes that contribute to increasing the capabilities of the athlete's body systems and maintaining performance. One of the biochemical changes resulting from the use of synchronization is the enzymes' role as reactions and natural responses to physical exertion. Among these enzymes is creatine phosphokinase (CPK), which is one of the enzymes that help accelerate energy release processes by combining with adenosine diphosphate (ADP) within the ATP-CP system, an energy production system for anaerobic activities. Additionally, lactate dehydrogenase (LDH), which removes hydrogen ions, helps produce energy through metabolic representation of lactic acid. One of the biochemical changes resulting from the adopted training method is its enhanced efficiency in carrying a greater amount of oxygen to the working muscles.

Based on the above, the significance of this research lies in designing training exercises using the synchronized training method to prepare players functionally and skillfully for the purpose of advancing performance during football matches.

It has been observed that there is a decline in physical capabilities among players, leading to their inability to maintain strength and speed throughout the entire duration of the match. This decline could be attributed to the insufficient physical training received by most young soccer players, which has weakened their abilities and potential. External physical exertion places strain on the internal organ system and imposes loads that necessitate adaptation.

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These loads are associated with physical effort and give rise to internal changes within the body, including significant biochemical alterations involving enzymes such as LDH and CPK. These variables play a crucial role in sustaining the continuous acceleration, release, and regeneration of energy required for physical exertion throughout the course of the match.

### Research Objectives

#### The research aims to

1. Design training exercises using the synchronized training method for football players aged 17-19.
2. Investigate the impact of synchronized training exercises on the enzymes (LDH-CPK) and skill performance in football among players aged 17-19.

### Research Hypotheses

1. There is a positive effect of synchronized training on the enzymes (LDH-CPK) and skill performance in youth football.

### Research Methodology

The researchers followed the experimental method as it aligns with the nature of the research problem. They employed a design using two equivalent groups (experimental and control) with pre-test and post-test measures.

### Population and Sample

The research population was identified as football players from youth clubs in the center of Wasit Governorate, including Al-Kut, Al-Jihad, Al-Azah, Al-Shuhada, Al-Sharqiya, Al-Nahreim, and Wasit clubs for the sports season 2022-2023, totaling 126 players. The research sample was purposefully selected and consisted of players from Al-Shuhada and Wasit youth clubs, meeting the research requirements. The sample size was 32 players, excluding goalkeepers and some players from each club due to their incomplete adherence to the training units, resulting in a final count of 20 players. The research sample was divided into two groups: the experimental group represented by the youth of Al-Shuhada club, and the control group represented by the youth of Wasit club, with each group consisting of 10 players. Thus, the research sample represented a percentage of 15.9% of the research population.

### Equipment, tools and means used in the research

#### Used Devices

1. BA 88 Semi Auto device for measuring the levels of enzymes (CPK, LDH).
2. Centrifuge device for blood separation, as shown in Appendix (9).
3. Two electronic timing watches (Casio brand).

#### Used Tools

1. Measuring tape.
2. 12 footballs.
3. Adhesive tape.
4. Various office supplies.
5. 20 barriers of different heights.
6. 40 cones of different heights.
7. Blood collection tools (syringes, sterilizer, cotton, clot-preserving tubes).
8. Cool Box (for temperature-controlled storage).

### Data Collection Methods

- Arabic and foreign sources.
- International information network (Internet).
- Tests and measurements.

### Biochemical Measurements

#### CPK and LDH Enzymatic Measurement

**Used Tools:** Sterilizer, cotton, disposable syringes, compression band for arm, clot-preserving tubes, BA 88 Semi Auto device.

A blood sample of 5 cc was drawn from the players before any physical exertion while they were in a resting state. The samples were taken from the venous blood in the forearm area and placed in special tubes to prevent blood clotting. The blood was drawn by a specialist doctor and stored in a Cool Box. The measurements were taken before the exertion when the players were in a fully rested state (without engaging in any physical activity) to determine their concentrations. Then the physical effort was performed, including the lactic tolerance test (Conconi and Volken protocols). This test involved running on a treadmill at maximum speed and an incline angle of 9, at a speed of 8 miles per hour (12.5 km/h) for 3 minutes. Immediately after the physical exertion, blood samples were taken using the same method as before the exertion to measure the concentrations of LDH and CPK enzymes before and after the exertion. The tests will be conducted using the BA 88 Semi Auto device.

### Skill Performance Test

The skill performance was evaluated by five specialized football referees. The tested players were assessed by observing them in a trial match, which was recorded on video and distributed to the referees on a CD. The trial match involved the experimental group represented by Al-Shuhada Club against Al-Kut Club, and a match between Al-Wasat Club and Al-Sharqiya Club on the same day. The same matches were repeated in both the pre-test and post-test evaluations. After watching the matches, the referees assessed the players using an evaluation form, and each tested player was given a rating on a scale of 10. (Ahmed & Sabry, 1997)

### Pre-Research Tests

On the following day, the pre-test for football skill performance was conducted at the Wasit Football Club stadium, precisely at 4:00 PM.

### Main Experiment

The researchers prepared exercises using the concurrent training method, which were applied to the experimental group at the Wasit Football Club stadium over the course of 24 training sessions spanning 8 weeks. These sessions took place three times a week on Sundays, Tuesdays, and Thursdays.

The concurrent training method used with the experimental group incorporated appropriate intensity levels suitable for the age group and training stage of the players. The exercises included skill-based training with resistance, using a weight of 1/2 kg on each leg, along with the resistance provided by competing players. This approach in skill-based exercises aimed to enhance the players' ability to generate the necessary force to effectively overcome both forms of resistance (opponent and weighted) during skill performance.

The principle of progression was taken into consideration during training. Speed, strength, and endurance exercises were conducted with varying intensities. Speed exercises ranged from 90% to 100% intensity. Strength exercises were performed using weights ranging from 50% to 75% of the individual's maximum, employing both low and high-intensity periodized training methods. Furthermore, endurance exercises were carried out using continuous load training. The aerobic endurance exercises began at a maximum heart rate range of 130-160 beats per minute to elevate the players' fitness level.

The training sessions were conducted during the specific preparation period, and the load was set at a ratio of 1:2. The intensity of the exercises was determined based on the best time to complete each exercise, maximum achievements in weights, and the highest heart rate during aerobic endurance

training, which was set at 160 beats per minute. The experiment commenced on Sunday, November 11, 2022, and concluded on Thursday, February 2, 2023.

### Post-Research Tests

The post-research tests for both the experimental and control groups were conducted on Sunday and Monday, on dates 5-6 February 2023. The researchers ensured that the same conditions were provided as in the pre-tests regarding the sequence and timing of the tests.

### Statistical Analysis

The statistical software package SPSS (Statistical Package for the Social Sciences) was used to process the data.

### Results

**Table 1:** Illustrates the differences between pre-test and post-test values of some biochemical variables and football skill performance for the experimental group.

Variants	Unit	Pre-Test		Post-Test		differences	T-Test	sig
		Arithmetic mean	standard deviation	Arithmetic mean	standard deviation			
Before performance	CPK	78.000	9.823	151.600	25.432	-73.60	5.676	0.002
	LDH	415.400	39.696	560.000	58.047	-144.60	4.507	0.006
After performance	CPK	122.600	11.524	222.600	43.535	-100.00	3.980	0.011
	LDH	447.000	32.140	733.000	72.205	-286.00	7.691	0.001
skill performance	degree	5.800	2.207	8.267	1.907	2.467	4.429	0.002

Significant at a level of significance  $< 0.05$  with degrees of freedom  $(10-1) = 9$ .

**Table 2:** Demonstrates the differences between pre-test and post-test values of some biochemical variables and football skill performance for the control group.

Variants	Unit	Pre-Test		Post-Test		differences	T-Test	sig
		Arithmetic mean	standard deviation	Arithmetic mean	standard deviation			
Before performance	CPK	92.600	15.821	118.400	19.165	-25.80	3.586	0.016
	LDH	386.400	72.642	487.600	20.840	-101.20	2.779	0.039
After performance	CPK	115.600	4.277	168.800	10.686	-53.200	10.783	0.000
	LDH	459.200	48.111	615.400	86.419	-156.20	2.600	0.048
skill performance	degree	5.167	2.397	7.030	1.207	1.863	4.384	0.004

### Discussion

The researchers attribute the increase in creatine phosphokinase (CPK) enzyme concentration before exertion to the fact that exercises often lead to improvements in internal metabolic processes, accompanied by changes in the levels of biochemical variables within muscle fibers in the long term. The increase in the concentration of this enzyme is considered an indicator of muscular training, which can be attributed to the nature of the exercises performed by both groups throughout the experiment. An increase in CPK concentration is considered an indicator of muscular training efficiency for athletes, while the level of creatine phosphate increases in trained individuals and decreases in untrained individuals. (Ali, 2014) <sup>[3]</sup>

Regarding post-exertion, researchers attribute the increase in CPK enzyme concentration to the nature of the exercises used, which resulted in an evolution in increasing this enzyme's concentration because the nature of the exercises requires the release of energy necessary for muscular work. Enzymes play an important role in the speed of energy production and release through accelerating metabolic processes within muscle cells to produce ATP. Therefore, creatine phosphokinase is considered one of the important factors directly involved in energy production, release, and reconstruction, as confirmed by (Salama, 2000) <sup>[6]</sup> (Hasan, Ali, & Shaalan, 2022) <sup>[3, 4, 5]</sup> who stated that "ATP reformation depends on the availability of the chemical compound creatine phosphate. The CPK enzyme transfers a group of

phosphates from the creatine compound to adenosine diphosphate (ADP) to form adenosine triphosphate (ATP) and vice versa." The exercises designed, including muscle work for generating force and speed through contraction and relaxation to overcome external resistance, require very high energy to fulfill this function. This cannot be achieved unless there are assisting factors for muscles to perform muscle contractions, and enzymes are the assisting substances for energy production. Hussein Abdul Amir, quoting Safaa Mara'ab, confirmed that "any muscle activity is accompanied by a series of chemical reactions in which enzymes play a supporting role, contributing actively and effectively. Thus, the activity of enzymes involved in anaerobic metabolism processes increases due to training." The enzyme itself increases as a result of high-intensity athletic training and for short periods because the muscle in this case needs to rapidly produce and reconstruct energy to continue physical exertion. Therefore, this enzyme plays a major role in the continuous reconstruction of energy. Enzymes associated with energy source levels also increase in order to regenerate ATP, including the CPK enzyme.

As for the increase in lactate dehydrogenase (LDH) enzyme before exertion, researchers attribute this increase to physical training and the nature of exercises characterized by high intensity and intermittent time periods, leading to an increase in the concentration and effectiveness of this enzyme. This increase occurs in the long term and cumulatively as a result of an increase in the amount of glycolytic enzymes in the

muscles, enabling players to perform in the absence of oxygen and according to anaerobic energy systems. They have the ability to work relying on lactic acid in energy production, as confirmed by Risan Khrebit Majid (1995) (Hasan, 2022, pp. 86-101) [3], who stated that "physical training often leads to an increase in LDH enzyme concentration if performed under anaerobic conditions, as an increase in its concentration indicates that the individual possesses a larger quantity of glycolytic enzymes, which enables them to perform lactate work.

The researchers attribute the increase in the concentration of creatine phosphokinase (CPK) before exertion to the fact that exercises often lead to improvements in internal metabolic processes, accompanied by changes in the biochemical variables within muscle fibers in the long term. The increase in the concentration of this enzyme is seen as an indicator of muscular training, which can be attributed to the nature of the exercises performed by the two groups throughout the experiment. An increase in CPK concentration is considered an indicator of muscle training efficiency for athletes, as the level of creatine phosphate rises in trained individuals and decreases in untrained individuals.

After exertion, researchers attribute the increase in CPK enzyme concentration to the nature of the exercises used, which resulted in an evolution in the increase of this enzyme's concentration. The nature of the exercises requires the release of energy necessary for muscle work, and enzymes play a significant role in the speed of energy production and release through accelerating metabolic processes within muscle cells to produce ATP. Therefore, creatine phosphokinase is considered an important factor directly involved in energy production, release, and reconstruction. Rebuilding ATP depends on the availability of the chemical compound creatine phosphate, and CPK enzyme transfers a group of phosphates from creatine compound to adenosine diphosphate (ADP) to form adenosine triphosphate (ATP) and vice versa. Enzymes also play a crucial role in facilitating muscle contractions during exercise, as they are the assisting materials in energy production. Any muscle activity involves a series of chemical reactions in which enzymes act as assisting factors, contributing actively and effectively to anaerobic metabolism processes, and this is due to training.

The LDH enzyme after exertion shows an increase, and researchers attribute this increase to physical training and the nature of the exercises characterized by high intensity and intermittent time periods, leading to an increase in the concentration and effectiveness of this enzyme. This increase occurs in the long term and accumulates due to the increased amount of glycogen in the muscles, enabling players to perform in the absence of oxygen according to the anaerobic energy systems, allowing them to work based on lactic acid production for energy. The LDH enzyme is responsible for the metabolic process of lactic acid, converting pyruvate to lactic acid for its use in producing the necessary energy for the required anaerobic muscular effort. Conversely, in the

presence of oxygen, it converts lactic acid back to pyruvate to complete the production of energy needed for muscle work in the presence of oxygen (aerobic system). Thus, it enhances the players' ability to perform, as indicated by Robert (2000) [7]: "The importance of this enzyme is evident when stimulating the reverse reaction, which produces energy (ATP) and reduces oxygen levels. On the other hand, the reaction in the opposite direction provides cells with pyruvic acid, which is oxidized in the citric acid cycle to produce energy in the presence of oxygen."

The increase in lactate dehydrogenase (LDH) enzyme effectiveness and activity is directly proportional to the intensity of training. If the physical effort exerted during training is high, the effectiveness and activity of this enzyme will also be high, as confirmed by Willmoer (1994) [8]: "The activity of CPK and LDH enzymes increases with high-intensity speed exercises, which are repeated and performed within 30 seconds.

### Skill Performance

It is evident that the skill performance level of the experimental group has significantly improved. This is clear from the significant differences between the pre-test and post-test results, with the advantage being in favor of the post-tests. In football, players cannot perform at the required level unless they have high potential in skill performance (technique), which helps them meet the demands of the game conditions. Football is characterized by a variable playing style dictated by the nature of the match, with quick and unexpected movements that require players to be physically and skillfully prepared to meet the game's requirements. (Hasan & Hasan, 2022) [3, 4, 5].

Based on this, researchers relied on the preparation of a synchronized training method that combines physical and skill aspects to achieve muscular contractions. The training sessions were characterized by repeating performances during training units and maintaining continuity in skill execution. Additionally, the timing of skill training within the training unit was considered, and the training sessions included a variety of basic football skills, whether with or without the ball. These skills included dribbling, passing, shooting, as well as defensive skills such as tackling and feinting. The difficulty of skill performance was increased by linking various football skills together because football skill performance is based on the players' ability to acquire motor skills, which reflect their influence on the player's performance to achieve neuromuscular coordination. Skill performance requires continuous training for players to be able to face their opponents.

Furthermore, "good execution of skill performance by players ensures their control of the ball and the ability to control the course of the game through maneuvering past opponents, deceiving them, and scoring from different distances. This requires speed, strength, and accuracy in performance through continuous and consistent training.

**Table 3:** Shows the differences in the post-test values of some biochemical variables and football skill performance between the experimental and control groups.

Variants		Unit	Experimental group		Control group		T-Test	sig	Type sig
			Arithmetic mean	standard deviation					
Before performance	CPK	Liter	151.600	25.432	118.400	19.165	2.251	0.048	Sig
	LDH		560.000	58.047	487.600	20.840	2.519	0.030	Sig
After performance	CPK	Liter	222.600	43.535	168.800	10.686	2.573	0.028	Sig
	LDH		733.000	72.205	615.400	86.419	2.255	0.048	Sig
skill performance		degree	8.267	1.907	7.030	1.207	3.421	0.026	sig

(\*) Statistically significant at a significance level of < 0.05 with degrees of freedom (20-2) = 18.

### **Discussion of the results of the values of some biochemical variables and the skill performance in football between the experimental and control groups in the post-measurement**

Based on the results of the post-measurement for both research groups, as shown in Table (3), significant statistical differences were found between the experimental group and the control group. The experimental group exhibited a higher level of concentration of enzymes (CPK and LDH) before and after exertion. Researchers attribute this superiority to the nature of the exercises used with the experimental group, which involved a diverse training method known as "synchronized training." This method included strength exercises, speed training, as well as aerobic exercises. The intense exercises performed for a short period of time resulted in rapid release of energy and its supply to the muscles involved in performance. Additionally, the diversity of sports activities used with this group allowed for greater muscle utilization, leading to greater muscle contraction speed aided by enzymes. These enzymes are essential factors in energy production and reconstruction, as confirmed by (Mannei, 2004), who stated that "high-intensity exercises lead to increased speed, activity, and effectiveness of anaerobic energy production. This is primarily due to the increase in adenosine triphosphate (ATP) stores within the muscles and phosphocreatine (PC) stores, in addition to increased activity of enzymes involved in chemical reactions and energy production, such as ATPase and creatine phosphokinase enzymes. The increase in enzyme activity and energy stores within the muscles leads to increased performance capacity and effort."

Furthermore, high-intensity sports training leads to an elevation in enzyme levels to perform their functions. This depends on the duration of exercise application, proper nutrition for the players, and their training age. A study conducted by Millard and others (1985) <sup>[10]</sup> found that the activity of enzymes (CPK and LDH) is influenced by several variables after training, including gender, chronological age, training age, training duration, relative intensity during the specified training period, and nutrition.

Therefore, the synchronized training method utilized with the experimental group resulted in significant improvements in biochemical variables and skill performance compared to the control group. The combination of strength, speed, and aerobic exercises, as well as the proper nutrition provided to the players, played a vital role in enhancing their performance and energy production capabilities.

### **Skill Performance**

Researchers attribute the observed differences in post-measurement tests between the experimental and control groups, favoring the experimental group, to the skill-based and systematic application of synchronized exercises. These skill-based exercises were characterized by intense time constraints and complexity. The planned exercises were executed as quickly as possible, while ensuring accuracy during passing, receiving, and scoring. Without precision in these aspects, there is no point in implementing planned exercises or even playing, as accuracy and speed in ball transition among players enable them to reach the opposing team's goal before the defending players are positioned and the goalkeeper is alert.

Achieving high physical fitness and comprehensive skill performance for all participating players in the planned exercise is crucial because a decrease in physical or skill level

of any player will lead to fewer opportunities for successful attacks and goal achievement. The relationship between physical fitness and skill performance requires significant effort from football players and a very high level of physical fitness due to the fast rotational and rhythmic movements performed during the game. Players cannot execute planned movements without possessing strength, agility, and speed.

Moreover, the assigned planned meals for the player, whether defensive or offensive, require speed in executing their specific duties, such as coverage, monitoring, defensive retreat, providing support and assistance, and quick forward movement to dangerous areas during attacks. All of these tasks require specific performance capabilities, as affirmed by Mohammed Mahmoud Abdel Zaher (2018): "Specialized exercises aimed at developing specialized motor performance aim to achieve the necessary physiological adaptations for the speed of attaining the automatic execution of the required motor patterns within the requirements of specialized sports, in line with the requirements of the motor situation through the speed of neuromuscular transmission, the synchronization of motor units, and the speed of recruiting muscle fibers necessary for performance within any model of motor performance used. Training on specialized exercise performance is a central and fundamental entry point that highlights the importance of clarifying the specificity of training and the requirements of competitive performance within the sport or specialized activity."

Therefore, specialized skill-based exercises aim to achieve the physiological adaptations necessary for the quick execution of required motor patterns within the specific requirements of the sport, in accordance with the demands of the motor situation. Training on specialized exercise performance is essential for clarifying the specificity of training and the requirements of competitive performance within the sport or specialized activity.

### **Control Group**

The control group has shown development in the dependent research variables, as indicated by the tables above. This development is a result of regular training and performance of exercises during the specific preparation period. The development can be attributed to the training exercises used by the coach, which had a positive impact on the development of biochemical variables and skill performance. The benefit of these exercises was also evident in the tactical aspect, as the coach considered some scientific foundations when designing them. The training process was executed gradually, which led to an improvement in the players' physical fitness and motivated them to perform the research tests. This is supported by Youssef Lazem Kamash (1999), who stated, "The daily training unit aims to bring players to a level of mastery in tactical motor skills, despite their abundance and variety. Therefore, these skills take a significant portion of the training unit's time. Tactical execution in football is an important aspect of the daily training unit, based on the principle that rapid tactical preparation and proper and accurate application of basic skills during performance are the foundation of the game of football. Without them, a player cannot execute the assigned tactical duties. A football player can be a good player if they grasp the basic skills and perform them as required. Therefore, the most important duty of training is to strive to bring the players to the highest level of training readiness."

Thus, the control group's improvement in dependent variables can be attributed to their adherence to regular training, the

effectiveness of the training exercises used by the coach, and the integration of scientific principles in their planning. The gradual execution of the training process has led to an enhancement of players' physical fitness and their ability to perform the research tests successfully. The focus on tactical execution in football has also played a crucial role in the daily training unit, as it forms the foundation of the game and enables players to fulfill their tactical responsibilities effectively.

### Conclusions

1. The researchers concluded that the synchronized training method contributed to an increase in the levels of the enzymes CPK and LDH, as well as skill performance in football, in the post-test measurements compared to the pre-test measurements.
2. The synchronized training method is an ideal training approach for the youth age group due to its positive impact on the development of the research sample.

### Recommendations

1. The researchers recommend the use of the synchronized training method to increase and enhance the efficiency of the biochemical variables represented by the enzymes CPK and LDH, as well as skill performance in football.
2. It is essential for the coaches in the research community to adopt training vocabulary that aligns with the nature and requirements of performance in the specialized activity.

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