The Impact of Using CrossFit Training on Lactic Acid Concentration (Physical Effort), Specific Endurance Levels, and Their Relationship to the Level of Offensive Skill Performance in Basketball

* DR / Walaa Abdel Azim Abdel Shafi Selim ¹ Introduction and Research Problem:

Sports have become a key indicator of a nation's political and cultural strength, prompting nations to prioritize the preparation of top athletes through research, studies, tests, and metrics to enhance sports programs and athlete training across various disciplines (16: 119).

Sports training now relies on established principles and technological advancements to help athletes reach high performance levels in specialized activities, forming the foundation of elite sports (23: 36).

Wagdy Mostafa Al-Fateh (2016) emphasizes that physical preparation is essential for any sport, serving as a foundational phase to develop and coordinate all muscle groups. Physical fitness exercises aim physiological to create positive changes, enhancing physical fitness performance. Physical and

preparation are interlinked, with fitness serving as the pathway to preparation, enabling athletes to reach highperformance levels. This preparation is critical for developing and mastering motor skills specific to specialized sports activities (19: 11).

Edward Dias (2008) highlights that various methods are used to prepare athletes for sporting excellence, with CrossFit training being one method that positively impacts performance (22: 23).

CrossFit, founded by **Greg Glassman in (2000)**, is a high-intensity fitness program combining strength training, cardio, and gymnastics. It aims to improve overall health, endurance, and strength through functional exercises like jumping, weightlifting, and climbing. A strong core is crucial for optimal performance in CrossFit (32).

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What makes CrossFit unique is its minimal equipment requirement, as participants themselves act as the tools. It is more of a lifestyle than a training routine, ensuring safety and significantly reducing injury risks compared to other sports (27: 2).

CrossFit is distinguished by three aspects: safety, efficiency, and effectiveness, enhancing its gradual impact on the body. This allows trainees to develop fitness progressively, starting with confidence in their inner strength and potential, followed by gradual adaptation through repetitive movements (28: 112).

Ali Galal El-Din (2006) describes fatigue as a state of emotional or physical stress caused by external factors, leading to physical tension (10: 437).

Baha El-Din Salama (2008) notes that physical exertion up to 30 seconds relies on the phosphagen energy system (ATP-CP). For exertion lasting over two minutes, the anaerobic glycolysis system becomes the main energy source, producing lactic acid, which hampers the muscle's ability to maintain intensity (3: 162). Haris (2001) states that lactic acid is a major cause of physical fatigue, which is linked to exhaustion. It is produced from glycogen, and its increase depletes carbohydrate stores. Muscle fatigue is not solely caused by glycogen depletion, as fatigued muscles cannot use glycogen due to reduced enzyme activity, caused by muscle acidity (25: 121, 122).

Abu Al-Ela Ahmed Abdel Fattah and Ahmed Nasr El-Din Radwan (2003) explain that lactic acid production decreases with increased oxygen consumption during exercise. Oxygen helps convert hydrogen ions and pyruvate into CO2 and H2O. Without enough oxygen, these convert into blood lactate. The circulatory aids lactate removal system by increasing blood flow, which helps transfer lactate to the heart, liver, and inactive muscles. Lactate buildup causes pain, but trained athletes can endure it due to improved biological regulation (1: 166, 167).

MohamedSobhiAbdelHamid (2005) explains that lactic acidfrom anaerobicglycolysiscausesfatigue.Completerecoveryinvolveseliminating excesslactic acidfrom the

muscles and blood. Light physical exercises during recovery, called cooldown exercises, speed up this process (14: 192).

Lactic acid is a key cause of physical fatigue, and measuring blood lactate levels during rest and exertion is an important indicator of fatigue and endurance. Since blood lactate responses to training are highly sensitive, training programs need specialized planning aligned with blood lactate responses (5: 89).

Basketball requires specific physical abilities, which are crucial for technical. enhancing tactical. psychological, and physiological aspects of players. A key quality for a basketball player is the ability to maintain speed and strength throughout the entire game without reaching fatigue, which depends on developing physical abilities tailored to these needs.

Basketball performance strains the body, particularly the cardiovascular and respiratory systems, leading to a decline in physical performance and, consequently, skill performance. **Sanjay Sharma** (2012) states that aerobic endurance is essential for maintaining consistent performance during long matches, making it a vital factor in achieving victory (29: 88).

The researcher attributes the fatigue problem to the insufficient time allocated for endurance exercises and the nature of the exercises not developing endurance effectively. As a potential solution, the researcher aims to study **the impact of CrossFit training on lactic acid concentration, specific endurance, and their relationship with offensive skill performance in basketball.**

Research Objectives:

The aim of the research is to investigate the impact of CrossFit training on:

1- Physical effort, represented by
(blood lactate levels at rest – blood lactate levels after exertion).

2- Specific endurance, represented by (performance endurance – strength endurance – speed endurance).

3- Some offensive skills in basketball, represented by (passing – dribbling – shooting).

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4. Research Hypotheses

1. There are statistically significant differences between the pre-test and post-test measurements in lactic acid concentration (physical effort), specific endurance levels, and skill performance levels (under investigation), favoring the post-test measurement.

2. There are statistically significant improvement rates between the pre-test and post-test measurements in the variables (under investigation), favoring the post-test measurement.

3. There is a correlation between the variables of lactic acid concentration (physical effort), specific endurance levels, and skill performance levels (under investigation).

Search Terms

CrossFit Training:

These are exercises that utilize body weight against gravity to build and develop strength, balance, flexibility, muscular endurance, agility, and power endurance. The exercises rely on the core muscles of the abdomen and back. They can be practiced by individuals of all ages, genders, and fitness levels. (26:20)

Physical Activity:

The state reached by an athlete after performing maximum physical effort, where they are unable to continue further performance. (17:76)

Lactic Acidosis:

The acid associated with a decrease in oxygen levels in the body, an inability to eliminate it, or both. (31)

Performance Endurance

The athlete's ability to sustain repeated motor skill executions with high efficiency over an extended period. (30)

Previous Studies

1- Buffield and Anderson (2014) (21)

This study examined the impact of CrossFit training on health-related physical fitness using an experimental approach over 12 weeks with 50 athletes divided into experimental and control groups (25 athletes each). Significant improvements were observed in the experimental group's aerobic capacity and muscular endurance.

2- Goins, Justin Michael (2014) (24)

This research focused on the physiological effects of CrossFit

training using an experimental method with 12 athletes over 6 weeks. Key results included enhanced aerobic and anaerobic capacity, maximal oxygen consumption, diastolic blood pressure, and energy system levels.

3- Aleksander Yurievich Osipov et al.(2017) (20)

The study assessed the effect of CrossFit training on the fitness levels of 16–17-year-old judo athletes through an experimental approach. Results highlighted the experimental group's superiority in competitive matches and lower blood lactate levels compared to the control group.

4- Taha Ahmed Mohamed Badawy(2018) (7)

This study focused on developing a training program using CrossFit exercises to evaluate their effects on physical attributes and technical performance in karate kumite players. Two groups, control and experimental, each with (10) players from Mallawi Sports Club in Minya The Governorate. were studied. findings demonstrated notable enhancements in reaction speed, execution speed, coordination. muscular power, flexibility, endurance,

and the effectiveness and frequency of attacks for the experimental group compared to the control group.

5- Mahmoud Adlan Abdel Rabah(2022) (15)

The research aimed to analyze the effects of a calisthenics-based bodyweight strength training program on core muscle strength, biomechanical performance variables, and discus throwers' digital performance. Conducted over (8) weeks with (8) athletes, the program led to improved physical and biomechanical abilities and statistically significant advancements in the athletes' digital performance.

6- Iman Askar Ahmed Ahmed (2020)(2)

This study examined the influence of CrossFit training on youth athletes under (13), targeting physical effort (resting and post-exercise blood lactate levels), endurance (performance, strength, and speed), and offensive technical skills. Involving (22) players from Al-Sharqiya Club in Zagazig under (14) years old, the experimental approach found CrossFit training reduced blood lactate levels, enhanced endurance, and improved offensive technical skills for judo players.

Research Procedures

Research Methodology:

The researcher used the experimental method using the experimental design of one experimental group, as it is suitable for the nature of this study.

Research Population and Sample:

The research population and sample were purposefully selected from

young athletes under (13) years old at Al-Sharqiya Sports Club in Zagazig for the (2023/2024) sports season. The population included (25) players, from which (10) players were chosen for the pilot sample. The main research sample comprised (15) players who underwent the CrossFit training program. The researcher ensured homogeneity within the actual research sample, as detailed in Table (1).

		Variables	Measuring unit	Means	standard deviations	medians	skewness coefficients	
		Age	Year	13,12	0,60	13	0,6	
variables	Basi	Height	Cm	158,6 4	2,49	159	0,43-	
	0	Weight	Kg	56,28	1,86	55	2,06	
		Training age	Year	4,08	0,75	4	0,32	
Physica	Physical	Lactic acid before exertion	(mmol/L)	1,68	0,05	1,67	0,6	
	leffort	Lactic acid after exertion	(mmol/L)	11,72	1,51	11	1,43	
<	т	Performance endurance	Degree	52,88	2,63	54	1,27-	
aria	hys	Speed endurance	Second	7,88	1,01	8	0,35-	
bles	ical	Strength endurance	Degree	31,12	2,22	32	1,18-	
variables	S	Passing and receiving from movement	Degree	11,52	1,26	11	1,23	
	kill	Control of ball handling with the left hand	Second	23,92	1,99	24	0,12-	

Table (1)

Means, standard deviations, medians, and skewness coefficients for the variables under study (Homogeneity of the population) (N = 25)

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Variables	Measuring unit	Means	standard deviations	medians	skewness coefficients
Control of ball handling with	the right				
hand					
Shooting from five different a	reas				
Control of ball handling with	the left				
hand					
Control of ball handling with	the right Second	22,04	2,11	22	0,05
hand					
Shooting from five different a	reas				
Control of ball handling with	the left				
hand					
Control of ball handling with	the right Degree	31,32	5,95	33	0,84-
hand					
Shooting from five different a	reas				

It is clear from Table (1) that the skewness coefficients ranged between (0.05, 2.06), meaning that all measurements under study fell within the range of (± 3) , indicating homogeneity of the research population in the variables under study.

Data Collection Methods:

The researcher collected information and data through a literature review of scientific references and previous studies related to the research topic.

First - Devices and Tools Used in the Research:

- Accutrend Lactate device for measuring blood lactate levels (Attachment 3)

- Restometer for measuring height in centimeters and body weight in kilograms (Attachment

- Stopwatch
- Measuring tape
- Battle Rope

- Plyo Soft Box (multi-height elastic step box)

- Basketball court

(4) The researcher reviewed numerous specialized scientific references in the field of basketball to determine the variables and physical tests (under study), as well as the opinion of experts (Attachment 1). This led to the identification of the following physical variables and tests:

- 1- Performance endurance test
- 2- Speed endurance test
- 3- Strength endurance test

Third - Skill Level (Attachment 5)

The researcher reviewed numerous specialized scientific references in the field of basketball to determine the skill variables and tests (under study), as well as the opinion of experts (Attachment 1). This resulted in the identification of the following skill variables and tests: passing, ball handling, and shooting.

Pilot Study:

The researcher conducted a pilot study on a sample of (10) players, selected randomly from the research population and outside the main research sample.

Scientific Validity of the Tests (Under Study): First: Validity:

The researcher assessed the validity of the tests using criterionrelated validity by ranking the research sample's scores descendingly, dividing them into quartiles, and comparing the highest and lowest quartiles. Table No. (2) shows this comparison.

Table (2)

Discriminant validity coefficient between the highest and lowest quartiles in the variables under study (N = 10)

					Averag	e Rank	(z)		
	Variables	Measuring unit	Mean of the highest quartiles	Mean of the lowest quartiles	(1)	(2)	Value on Mann- Whitney test"	probability (sig) p- value"	
	Lactic acid before	(mmol/L)							
"Phy exert	exertion		1,71	1,62	8	3	2,643-	0,008	
'sica tion'	Lactic acid after	(mmol/L)	10.00	10				0.000	
	exertion		13,80	10	8	3	2,660-	0,008	
"Ph vari:	Performance endurance	Degree	54,60	50,60	8	3	2,730-	0,006	
ysic able	Speed endurance	Second	8,60	6,60	8	3	2,694-	0,007	
s" al	Strength endurance	Degree	33,40	29,80	8	3	2,660-	0,008	
S.	Passing and receiving on the move	Point	13	10,40	8	3	2,668-	0,008	
kill va	Control in dribbling with the left hand	Second	24,60	21,40	7,90	3,10	2,683-	0,007	
riable	Control in dribbling with the right hand	Second	22,20	20,20	7,90	3,10	2,612-	0,009	
, S	Shooting from (5) different areas	Degree	31	22	8	3	2,643-	0,008	

Statistically significant at a level < 0.05

Table (2) shows that all p-values (0.006, 0.009) are below the significance level for all variables, significant differences indicating between the non-distinguished and distinguished groups, in favor of the distinguished group.

Secondly: - The reliability of the tests under investigation:

The reliability coefficient was calculated by applying the test to an exploratory sample of (10) players, with a (7)day interval. Table (3) shows the reliability of the tests.

Table (3)

Correlation coefficient between the first and second applications on the reliability of the variables under investigation (under investigation) for the exploratory sample (N = 10)

	Variables	Measuring unit	First application X Y		Second application X Y		(R) value	
Physical	Lactic acid before exertion	mmol/L	1,67	0,05	1,66	0,05	*0,999	
exertion	Lactic acid after exertion	mmol/L	11,90	2,23	11,85	2,10	*0,998	
_	Performance endurance	Degree	52,60	2,36	52,80	2,20	*0,963	
Physical	Speed endurance	Second	7,60	1,17	7,40	1,50	*0,981	
variables	Strength endurance	Degree	31,60	2,17	31,80	1,87	*0,962	
variables	Passing and receiving on the move	Points	11,70	1,56	11,90	1,44	*0,915	
_ Physical	Controlling dribbling with the left hand	Second	23	1,88	25,70	2,11	*0,893	
exertion – Physical	Controlling dribbling with the right hand	Second	21,20	1,22	21,10	1,28	*0,969	
variables	Shooting from five different areas	Degree	26,50	4,88	26,60	4,78	*0,998	

The value of (R) at the (0.05) significance level, with degrees of freedom (df = 8), is 0.666.

It is evident from Table (3) that there is a statistically significant correlation at the 0.05 significance level, with reliability coefficients ranging between (0.893 and 0.999.) This indicates the reliability of the variables under investigation.

Proposed CrossFit Training Program: Appendix (6) The researcher created a CrossFit training program following a review of available scientific literature, online resources, and instructional videos related to these workouts.

Program Objectives:

The CrossFit training program aims to improve lactic acid levels during rest and after exertion, enhance specific endurance (performance, speed, strength), and improve skill performance.

Program Framework: Appendix (7)

The program ran for three months (12 weeks) with three sessions per week, each lasting 80-95 minutes. Each session included:

1- Warm-up: (15) minutes: This part prepares the body's muscles and systems for the main workout.

2- Main Part: (40-50) minutes: It involves CrossFit exercises like Battle Rope and Plyo Soft Box, progressing in difficulty, using all parts of the body, and technical skill training for (20-25) minutes.

3- Cool-down: (5) minutes: Includes relaxation, cool-down exercises, and breathing techniques.

The program was conducted in the morning without affecting the club's existing schedule, except for adjusting loads to suit the program.

4- Training Load in the Program:

Based on a review of various studies and references, the researcher progressively increased the training load within the program's sessions. The optimal intensity was set between 60% and 85% of the maximum intensity.

Steps for Conducting the Experiment:

Pre-test Measurement:

The researcher conducted the pre-test for the study group on January 1 and 2, 2023, on the variables under investigation.

Main Experiment Implementation:

The proposed program was applied to the main study group from January 14 to April 12, 2023, over (12) weeks with (3) sessions per week, totaling (36) sessions. Each session included warm-up, CrossFit exercises, skill training, and cool-down. Training took place on Saturday, Monday, and Wednesday mornings, separate from team training.

Post-test Measurement:

The post-test for the study group was conducted on October 13 and 14, 2023, under the same conditions as the pre-test.

Statistical Treatments:

Based on the research objectives and hypotheses, the statistical methods used to analyze the data were as follows:

• Mean

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- Standard deviation
- Median
- Skewness coefficient
- Pearson correlation coefficient

First: Presentation of Results:

• Wilcoxon test

- Mann-Whitney test
- Percentage of improvement rate (%).
- Table (4)Significance of the differences between the pre-test and post-testmeasurements in the variables (under investigation)(N = 15)

					Mean ra	anks	(z) value from the	_
Variables		Measuring post-test unit measurements		pre-test measurements	(1)	(2)	Wilcoxon test	sıg (p.value)
Phy: exei	Lactic acid before exertion	mmol/L	1,68	1,57	21	10	3,443-	0,001
sical	Lactic acid after exertion	mmol/L	11,60	10	20,60	10,40	3,368-	0,001
ς Ρ	Performance endurance	Degree	53,06	58,93	10,20	20,80	3,330-	0,001
hysica ariable	Speed endurance	Second	8,06	6,80	20,13	10,87	2,972-	0,003
S a	Strength endurance	Degree	30,80	33,66	11,07	19,93	2,782-	0,005
	Passing and receiving on the move	Points	11,40	13,26	10,23	20,77	3,348-	0,001
Skill va	Controlling dribbling with the left hand	Second	24,53	22	20,53	10,47	3,167-	0,002
ariables	Controlling dribbling with the right hand	Second	22,60	18,93	20,77	10,23	3,296-	0,001
	Shooting from five different areas	Degree	34,53	40,26	10,63	20,37	3,052-	0,002

Statistically significant at a significance level of < 0.05

As shown in Table (5), all the calculated p-values range from (0.001 to 0.005,) which means the difference

between the pre-test and post-test measurements is significant and statistically meaningful, favoring the post-test measurement.

Table (5)	
Improvement percentages between the pre-test and	post-test measurements in the
variables (under investigation)	(N = 15)

	Variables	Measuring unit	pre-test x	post-test y	Improvement percentages %
Phy; exei	Lactic acid before exertion	mmol/L	1,68	1,57	%7,006-
sical	Lactic acid after exertion	mmol/L	11,60	10	%16-
Ph var	Performance endurance	Degree	53,06	58,93	%11,06
ysic: iable	Speed endurance	Second	8,06	6,80	%18,15-
ss al	Strength endurance	Degree	30,80	33,66	%9,28
- P Phy:	Passing and receiving on the move	Points	11,40	13,26	%16,31
Skill , hysic; sical v	Controlling dribbling with the left hand	Second	24,53	22	%11,5-
variab al exei ariabl	Controlling dribbling with the right hand	Second	22,60	18,93	%19,38-
les rtion es -	Shooting from five different areas	Degree	34,53	40,26	%16,59

There are different improvement percentages between the pre-test and post-test measurements, favoring the post-test in the variables (under investigation).

Table (6)

Correlation matrix between physical endurance, specific endurance, and offensive technique (under investigation)

Variables	Lactic acid before exertion	Lactic acid after exertion	Performance endurance	Speed endurance	Strength endurance	Passing and receiving on the move	Controlling dribbling with the left hand	Controlling dribbling with the right hand	Shooting from five different areas
Lactic acid									
before									
Lactic acid									
after exertion	- *0,568								
Performance	-	-							
endurance	*0,574	*0,527							
Speed	-	-	*0.565						
endurance	*0,719	*0,721	*0,565						
Strength endurance	*0,538	*0,550	*0,634	*0,856					
Passing and receiving on the move	- *0,698	*0,533	*0,627	*0,762	*0,581				
Controlling dribbling with the left hand	*0,927	*0,583	*0,855	*0,544	*0,958	*0,668			
Controlling dribbling with the right hand	*0,793	*0,650	*0,524	*0,580	*0,590	*0,636	*0,563		
Shooting from five different areas	*0,528	*0,541	*0,873	*0,590	*0,655	*0,604-	*0,878	*0,560	

The critical value of (\mathbf{r}) at (0.05) significance level is (0.514.)

Table (5) shows statistically significant correlation coefficients at the (0.05) significance level between the variables of physical effort, specific endurance, and skill performance level.

Second: Discussion of Results:

There are statistically significant differences between the pretest and post-test measurements in lactic acid concentration (physical effort), specific endurance, and skill performance level (under investigation), favoring the post-test.

As shown in Table (4), there are statistically significant differences with a p-value ranging from (0) to (0.009,) which is less than the (0.05) significance level, between the pre-test and post-test for the experimental group, favoring the post-test in the variables under investigation.

From Table (4), it is clear that there are statistically significant differences in lactic acid (physical effort) during rest and after exertion. The researcher attributes this to the use of CrossFit training, which includes a variety of exercises, such as free training and workouts with weights, which have a positive effect on improving lactic acid levels.

Iman Askar Ahmed (2020) attributes the difference in blood lactate levels during rest and after exertion to increased muscle effort, which raises energy demands and oxygen needs, resulting in lactate accumulation when oxygen is insufficient (2:20).

Saad Kamal Taha and Ibrahim Yehya Khalil (2004) (5) explain that physical activity increases lactate production when oxygen supply is inadequate, indicating anaerobic metabolism, with lactate levels rising up to ten times the resting level.

The researcher notes that after (12) weeks of training, physiological adaptation led to reduced lactate levels in the post-test, due to the structured, scientifically planned training using modern methods.

Table (4) shows statistically significant differences in specific endurance and skill performance levels, favoring the post-test. The researcher attributes this to CrossFit training, which improves health, endurance, and strength through high-intensity functional exercises like jumping, weightlifting, and climbing. CrossFit focuses on the core, enhancing overall performance (32).

CrossFit also emphasizes safety, efficiency, and effectiveness, leading to gradual progress in physical fitness. Trainees first gain confidence in their strength, then improve through repeated training, allowing the body to adapt (28:112).

Beha'a El-Din Salama (2000) (6) highlights that regular training enhances muscle efficiency, increasing strength and contraction speed, while improving endurance, which depends on muscle performance (3:245).

Skills are linked to physical fitness components, essential for successful athletic performance and growth, as seen in basketball, where physical fitness is crucial for training and education (13:303).

Although skill is important, its effectiveness is amplified with physical preparation. A player not physically fit may tire and lose the ball frequently, affecting performance. A physically prepared player finishes strong, controls the ball, and makes sound decisions (8:127).

The researcher views CrossFit training, combining strength, cardio, and gymnastics movements, as a highintensity program that improves endurance, strength, and offensive skill performance. It involves functional exercises like jumping, weightlifting, or climbing.

This agrees with "**Essam Abdel Khalek''** (2005), who stated that skill performance is closely linked to specific physical abilities, and mastery depends on developing these abilities (9:189). This view is supported by studies from "Paveld, Anderson" (2014) (21), "Gwynes, Justin Michael" (2014) (24), "Alexander Yurievich, Osipov, et al." (2017) (20), "Taha Ahmed Mohamed Badawi" (2018) (7), "Mahmoud Adlan Abdel Rabah" (2022) (15), and "Iman Askar Ahmed" (2020) (2).

Thus, the first hypothesis is confirmed, which states: "There are statistically significant differences between the pre-test and post-test in certain lactate concentration, specific endurance, and offensive skill performance levels, favoring the posttest."

Discussion of the second hypothesis, which states that "There are statistically significant improvement percentages between the pre-test and post-test in the variables (under research), favoring the post-test."

Table (6) reveals significant differences in the improvement percentages between the pre-test and post-test, with the post-test showing better results. These differences were found in lactate acid levels (before and after exercise), physical variables (performance endurance, speed

endurance, and strength endurance), and offensive skills (passing and receiving on the move, dribbling control with both hands, and shooting from five different spots). The improvement percentages were as follows: (-7.006%, -16%, 11.06%, -18.15%, 9.28%, 16.31%, -11.5%, -19.38%, 16.59%).

The researcher attributes these improvements to the CrossFit training program, which is designed based on scientific principles and focuses on maximum-intensity exercises. These exercises are tailored to improve the muscles and systems used in basketball, helping to enhance performance. Most studies suggest that an (8 to 12-)week duration, with (3 to 5) sessions per week, is optimal for improving skills and helping the body adapt for specialized sports performance.

The results indicate that the CrossFit program contributed to the improvement of various physical attributes. It had a positive impact due to its inclusion of continuous exercises, focusing on strength and speed, and using appropriate intensities to develop the targeted fitness elements. The program also determined the necessary performance duration to align with fitness development needs.

The researcher believes that the improvement in skill performance was due to enhanced physical abilities, which allowed players to perform basic skills efficiently without fatigue. As a result, players executed skills with high proficiency. The program's focus on technical performance positively influenced skill levels.

This aligns with the studies of "Pafield, Anderson" (2014) (21), "Gwynes, Justin Michael" (2014) (24), "Alexander Yurievich, Osipov, et al." (2017) (20), "Taha Ahmed Mohamed Badawi" (2018) (7), Mahmoud Adlan Abdel Raba (2022) (15), and Iman Askar Ahmed (2020) (2).

Thus, the second hypothesis is confirmed, which states that there are differences in the percentage improvements between the pre-test and post-test, favoring the post-test.

Discussion of the third hypothesis: There is a correlation between the variables of lactate concentration (physical effort), level of special endurance, and level of offensive skill performance (under investigation).

The results in Table (7) show a correlation between physical effort, special endurance, and offensive skill performance. There is a negative correlation between lactate concentration before and after exertion and performance endurance and speed endurance-lower lactate concentration led to increased repetitions in these tests, with constant time. A positive correlation was found between lactate concentration and strength endurance, where lower lactate concentration reduced time in strength endurance tests.

Additionally, the results show a positive correlation between lactate concentration and offensive skill techniques—lower lactate concentration led to better basketball performance in skills under investigation.

Table (6) reveals a positive correlation between physical variables (performance endurance, speed endurance, and strength endurance) and offensive skill variables (passing, receiving while moving, ball handling with the left/right hand, and shooting from five areas). The researcher attributes these correlations to the nature of CrossFit training, which prepares athletes for the demands of basketball offense and endurance helps improve for performance, speed, and strength. This confirms the third hypothesis, stating: "There is a correlation between lactate concentration (physical effort), special endurance. and offensive skill performance."

Conclusions and Recommendations:

First: Conclusions:

Based on the research objectives, hypotheses, the sample used, the tools, and the statistical treatments, the following conclusions were reached:

- The CrossFit program led to positive changes in delaying the onset of fatigue, as regular participation in this proposed training program reduced lactate concentration in the blood.

- The CrossFit program led to an improvement in physical fitness levels and enhanced the skill performance of basketball players.

- Conduct research in the field of basketball using CrossFit training to evaluate its effectiveness in developing and improving performance across different age groups and skill sets.

Second Recommendations

- It is essential to consider all aspects of the athlete's physiological, skill-related, and physical condition when designing a training program.

- Conduct similar studies on other samples and under different physiological conditions.

- It is necessary to integrate CrossFit training into basketball training programs.

- Emphasize the use of CrossFit training during special preparation periods due to its importance in developing the physiological and physical capacities of players.

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