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The relationship of some indicators of aerobic and anaerobic capacity to the accuracy of serving skill performance in racket games

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Abstract
Serving is one of the basic skills shared in racket games, which requires many physical, bodily and functional aspects that help the player to be able to perform it successfully. Therefore, the racket player needs anaerobic energy that develops strength and speed in performing the serving skill. As for aerobic energy, it is necessary to be able to continue playing for a long time without feeling tired, which means developing the aerobic system that serves to achieve the required achievement. The research aimed to identify the relationship between the values of some indicators of aerobic and anaerobic capacity with the accuracy of the performance of the serving skill among racket players (tennis - badminton - squash - table tennis) whose number is (20) as well as the nature of the differences between them through the use of functional tests for the aerobic and anaerobic capacity index that were agreed upon by specialists and received an acceptance rate of more than (50%). The researcher used the descriptive approach - survey study using the correlational method to suit the nature of the problem.
The researchers concluded: That most of the relationships between the aerobic and anaerobic capacities of racket players are not significant, which indicates the existence of weakness in most of the energy production contributing to the performance of these players.
The researchers recommended: The necessity of emphasizing the development of anaerobic lactic capacities and cyclic respiratory fitness in a manner that is consistent with the nature of performance for each of the racket games and in a way that achieves the functional efficiency required to perform the various skills.

Keywords: Aerobic, anaerobic capacity, accuracy

Introduction
The systems required to produce energy vary depending on the type of sports activity. There are activities that require an aerobic energy system and others that require an anaerobic energy system, and some of them depend on a mixture of both systems. Anaerobic and aerobic capacity indicators are a measure that reflects the level of efficiency of physical and functional preparation and the development of achievement. Thus, the functional capabilities of each player must be compatible with the requirements of the motor duty assigned to him, as some situations during the match require rapid movement to perform a specific skill duty, and thus the muscular work is characterized by an anaerobic nature, and there are other situations that require continuing to play for a long time and with reduced intensity, and thus the muscular work will be characterized by an aerobic nature.
Since serving is one of the basic skills shared by racket games, which requires many physical and functional physical manifestations that help the player to be able to perform it successfully, the racket player needs anaerobic energy, which is a development of strength and speed in performing the skill. As for aerobic energy, it is necessary to be able to continue playing for a long time without feeling tired, and this means the development of the aerobic system that serves to achieve the desired achievement [1]. The importance of the research lies in identifying the relationship between some indicators of anaerobic and aerobic functional capacity and the level of accuracy of serving in racket players, given the importance of this

capacity in achieving achievement at the individual level for the player and the team in general.

Research Problem

Racket games require varying amounts of movement, which results in relatively different anaerobic and aerobic abilities that depend on vital devices that work efficiently to meet the requirements and duties and to bring about the required functional changes as a result of the effort exerted by the players during the match, which is reflected in the distinguished performance of strength, speed and endurance.
However, the researchers noticed differences in the indicators of anaerobic and aerobic ability among young racket players, as well as the variation in their level of serve accuracy, and therefore decided to identify the level of these indicators and their relationship to serve accuracy in order to develop their abilities and skills.

Research objective

- The research aims to identify the relationship between the values of some indicators of aerobic and anaerobic capacity and the accuracy of the performance of the sending skill among racket players, and the nature of the differences between them.

Research hypotheses

1. There is a correlation between some indicators of anaerobic and aerobic capacity and the accuracy of the performance of the sending skill among racket players.
2. There are differences in some indicators of anaerobic and aerobic capacity among racket players.

Research field

1. Human field: Players of youth teams in racket games for the sports season 2023-2024.
2. Stadiums of the Faculty of Physical Education and Sports Sciences - Future University
3. Time field: The period from 12/15/2023 - 4/15/2024.

Research Methodology

The descriptive approach was used using the correlational method because it is suitable for the nature of the problem, because it can be used to extract information, set indicators and build future predictions.

Research Sample

The research sample consisted of (20) twenty players who were deliberately selected from the players of the Faculty of Physical Education and Sports Sciences - Future University in racket games, at a rate of (5) five players for each of the games (tennis - table - badminton - squash). The skewness coefficient was used to homogeneity the sample, as shown in Table (1).

Table 1: Shows the homogeneity of the research sample

Variables	Units	Mean	STD	Median	Skewness
Age	Year	21.7	0.80	17	2.625
Length	Cm	171.85	5.63	171	0.452
Weight	Kg	61.75	8.20	61	0.274
Training age	Year	4.6	1.60	4	1.125

The variables of age, height, weight and training age of the research sample showed that the values of all the skewness coefficients for these variables were limited between (± 3), which means that all sample members were distributed in a moderate distribution, which indicated their homogeneity.

Research tools

1. Arab and foreign sources and studies related to the research. 2. Observation and experimentation.
2. Personal interviews.
3. Information recording form for functional and skill tests.
4. Wooden box (Step set) with a height of (40) cm.
5. Rackets and balls (tennis, badminton, squash, table).
6. Stopwatches.
7. Medical scale for measuring weight.

Steps to implement the research

The researcher created a questionnaire to determine the functional tests for the anaerobic and aerobic capacity index, and it was distributed to a group of people with experience and expertise. The results of this questionnaire showed the following, as shown in Table (2).

Table 2: Shows the percentage of agreement on the tests by experts and specialists

Functional tests	S	Acceptable Tests	Agreement rate
Anaerobic capacity tests (phosphagenesis)	1	Step test for (10) seconds. Sargent test.	81.82%
Anaerobic (lactic) capacity tests	2	Step test (30) seconds.	72.73%
Aerobic capacity tests	1	Queens test (3) minutes. PWC 170 test using Step set. VO_2Max relative oxygenation index.	81.82%

The tests that exceeded the acceptance rate of more than 50% were selected, as the researcher has the right to choose the percentage he deems appropriate (Mohammed Hassan Alawi, and Mohammed Nasr El-Din, 2000, 326). The researcher found the reliability coefficient by retesting the test with an interval of five days using the simple correlation coefficient (Pearson) between the two tests, and also found the validity with each test after describing the method of conducting it, and after presenting it to experts in order to judge the validity of its content, it was agreed that it measures the goal for which it was set. The correlation coefficient appeared with good values, which confirms that the tests enjoy a high degree of stability, and that they are characterized by high objectivity.

Phosphagen Anaerobic Capacity Tests [2]

- **First test: Step test for (10) seconds**

The tester is weighed and then stands facing a bench or box with a height of (40) cm and places one of his legs on the bench (the leg he prefers) while the other leg is free on the ground and extended straight with the back, and is not used to push up by the swing. The number is one for the top (above the box) and two for the bottom (below) for (10) seconds up and down, after which one step is counted for each ascent and descent.
The reliability coefficient for this test reached (0.87) and the self-validity coefficient (0.93) which confirms that it enjoys a high degree of stability and validity in its content.
The anaerobic phosphagen capacity was calculated using the

following equation after converting the height of the platform from (40) cm to (0.4) meters in order to unify the unit.

- **The second test: Sargent's test**

The tester stands facing the wall with his right shoulder (arm shoulder) then raises his arm that is on the wall holding a piece of chalk to make a mark on the wall at the maximum point that the fingers can reach, then swings the arms and bends the knees in order to jump as high as possible to make a second mark with the arm adjacent to the wall at the maximum point that the fingers can reach.
Each tester is given three attempts, the best of which is counted, and the distance between the first and second marks is calculated in centimeters and converted to meters. It is processed with the following equation:
The sphenoidal capacity = 21.67 × weight (kg) × the difference between the two dimensions.
The reliability coefficient of this test reached (0.85) and the self-reliability coefficient (0.92).

Anaerobic (lactic) capacity tests [3]
Step test for (30) seconds
This test is similar to the first test (step test steps for (10) seconds), except that the steps are recorded during a period of (30) seconds, and are calculated according to the following equation:

Lactic capacity = 1.33 × Athlete's weight (kg) x 0.4 m x number of steps in 30 sec/Time 30 sec

The reliability coefficient of this test reached (0.87) and the self-validity coefficient (0.93).

Aerobic capacity tests [4]
1. Queens test (3 minutes)
The tester stands in front of a box with a height of (40) cm and when the signal is given to start, he performs the step with four counts with the feet on the ground, and the total time for the test is (3 minutes). There must be (22 steps) in each minute, where the pulse is calculated during (15 seconds) followed by (5 seconds) of rest or after stopping the test, noting that the pulse is multiplied by (15 x 4) to obtain the pulse rate per minute, which is measured by the sensing method above the radial artery. The functional aerobic capacity is calculated using the equation (VO_2 Max)

Aerobic capacity = 1.33 - (0.24 x calculated pulse rate per minute in the Queens test).

The reliability coefficient for this test reached (0.91) and the self-validity coefficient (0.95).

2. PWC 170 relative test using (Step test)
This test is performed by giving two different intensity efforts, each lasting (3 minutes), followed by a rest for (3 minutes) and the pulse is measured after the end of the first effort and the second effort, where the tester stands facing the platform (wooden box) which is a rectangular parallelepiped with three dimensions of length (50 cm), width (40 cm) and height (40 cm), and the tester is asked to work on the Step test device with effort for (3 minutes) and the pulse is measured for (15 seconds) after a rest (5 seconds) or after stopping the performance, noting that the pulse is multiplied by (15 x 4) to obtain the pulse rate per minute and after (3 minutes) of rest, a second (3 minutes) effort is given and upon its completion, the pulse rate is also calculated in the same way and is Record the number of steps each time you go up and down with one step.

The aerobic functional capacity is calculated using the following equation
N = Work effort done
WT = Athlete's weight
h = Height of the box (m)
n = Number of times you go up and down (steps)

After extracting the first effort and the second effort, the following equation is applied

PWC170 (Physical Working Capacity) = Physical work efficiency at pulse 170 / beats / min

N1 = First effort N2 = Second effort
PS1 = Pulse value at first effort S
PS2 = Pulse value at second effort

The reliability coefficient for this test was (0.98) and the self-validity coefficient was (0.94).

4. Extracting the maximum relative oxygen consumption

VO_2Max

5. (Karpman, 1974, 60) [6]
VO_2Max was extracted indirectly using the Karpman equation and adopting the value of PWC170, which is:

$VO_2Max = 1.7 \times PWC170 + 1240$

The reliability coefficient of this test was (0.98) and the self-validity coefficient was (0.94).

4. Extracting the maximum relative oxygen consumption

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VO_2 Max was extracted indirectly using the Karpman equation and adopting the value of PWC170, which is:

$VO_2 Max = 1.7 \times PWC170 + 1240$

Then extracting the value of the maximum relative oxygen consumption VO_2 Max by dividing the value of VO_2 Max by the weight of the athlete.
Thus, the reliability coefficient of this test was (0.84) and the self-validity coefficient was (0.91).
3 - 5 - 4 Serving skill tests for racket games
3 - 5 - 4 - 1 Tennis

Each player is allocated (10) serving attempts and the ball must fall within the boundaries of the serving area and with specific evaluation marks from (1-6) degrees.

Badminton
The tester is given (12) attempts to serve, which he must drop in the areas marked by dots, as shown in Figure (2), and only his best (10 attempts) are counted. The process of calculating the points.
(5) points are given if the shuttlecock falls in the area designated at a distance of (45 cm) outside the back

boundaries of the court in addition to (40 cm) inside the boundaries of the court after the back line of the direct court, and the examiner is also given (2, 3 4) points if the shuttlecock falls in the areas designated at (40 cm) respectively after the area marked with (5) points. The examiner is given one point if the shuttlecock falls in the area designated at a distance of (175 cm) which starts from the end of the area marked with dots (2) and ends with the imaginary line extending below the net. One point is subtracted for each attempt that does not cross the net. If the shuttlecock falls on a line between two points, the highest score is given, and if the shuttlecock goes outside the court (except for the marked areas) or gets stuck in the net, no points are given. The maximum number of points in the best (10) attempts is (50 points).

Squash

Five square targets are drawn in the middle of the front wall of the squash court at a height of (3) meters from the service line, such that the distance of the first square is (30 x 30) and the distance between square and square is (20) cm. Points are given according to the index for each square.

Table

Each player is allocated (10) serving attempts, so that the ball falls within the boundaries of the serving area, marked with (1-6) points.
A grade is given for each successful attempt. If the ball goes out of bounds, it is given a zero. After that, the total number of (10) attempts is calculated and the arithmetic mean is extracted.

Results and Discussion

Table 3: Values of anaerobic and aerobic functional capacity tests and sending skill

Tests	Tennis		Table		Badminton		Squash	
	Mean	STD	Mean	STD	Mean	STD	Mean	STD
Test (10 sec) kg. m/sec	59.68	8.52	58.90	8.31	60.43	12.5	65.72	9.27
Sargent test kg. m	535.02	66.71	715.45	79.87	654.74	66.29	595.40	123.04
Test (30 sec) kg. m/sec	62.56	8.21	66.00	14.44	60.65	15.31	59.45	8.51
Quinn's test kg. m/min	18.03	0.88	18.36	0.84	18.59	0.45	18.03	0.79
Test PWC170 kg. m/sec	24.39	3.98	21.32	1.47	22.63	1.36	25.97	0.96
VO2Max Test ml.kg.min	62.84	9.92	54.51	3.06	60.09	2.33	65.30	2.73
Sender Skill Performance Level	3.54	0.598	3.74	0.720	3.38	0.356	3.52	0.544

When we look at Table (3), we find that the values of the functional anaerobic and aerobic capacity tests for all players in various racket games were close in some and varied in some of them, and this is evidence that there is a difference and similarity in these abilities among players practicing these games.
As for the level of performance of the serving skill, we find a clear convergence between them, as most of its results were limited between (3.38) for badminton and (3.74) for table tennis.
In order to reach the correlation relationship between the aerobic and anaerobic capacities and the level of performance of the serving skill in racket games (tennis, table tennis, badminton, squash), the researcher conducted a simple correlation coefficient (Pearson) to reach the results shown in Table (4).

Table 4: Evaluates the correlation between aerobic and anaerobic capacities and the level of serve accuracy in racket games

Anaerobic and aerobic capacity	Tests	Games				Table value
		Tennis	Table	Badminton	Squash	
Anaerobic phosphagen capacity	10 Second Test	0.239	0.819	0.488	0.433	0.878
	Sargent Test	0.453	0.432	-0.226	-0.887	
Anaerobic lactic capacity	30 Second Test	0.932	0.906	0.084	0.308	
Aerobic capacity	Queens Test	0.990	0.048	0.38	0.149	
	PWC170 Test	0.473	0.224	0.997	0.991	
	VO_2 Max Test	0.979	0.699	0.502	0.25	

By observing Table (4), we find that there is a significant correlation between both the serving skill and the Sargent test for squash players, as the correlation value was inverse (-0.887) and is greater than the tabular value under the significance level (0.05) and the degree of freedom (3) which is (0.878), indicating that there is a strong correlation between this skill and the phosphagen ability that distinguishes squash players, as it requires them to repeat quick explosive movements according to the rules of the game and the nature of the court. As for the (10) second test, the results were not significant because they were less than the tabular value which is (0.878), and this indicates a defect in the training of the players, as one of the most important requirements that racquet players should possess in general is anaerobic ability (Amr Allah Ahmed, 1998, 79). The lack of correlations for most variables indicates that this system was not as efficient as required for the research sample to accomplish short muscle contractions, which is a very important necessity in applying the sending skill. As for the anaerobic (lactic) ability test, a significant correlation appeared between the (30) second test and the sending skill for tennis players with a value of (0.932) and table tennis (0.906), while badminton and squash did not show a correlation because it was less than the tabular value of (0.878). The researcher attributes the reason for this to the fact that anaerobic (lactic) capacity differs for racket players, as the percentage of lactic acid accumulation in the blood and muscles increases with the number of rounds of the match or according to the nature of the game, but this does not mean that training does not include exercises to develop this capacity, as racket players should be characterized by a high ability to resist fatigue to face the nature of the tasks and duties placed on their shoulders when playing [5].
By observing Table (4), we find that the aerobic capacity tests

(Queen's test) showed a strong correlation with tennis only, as its value reached (0.990), which is higher than the tabular value of (0.878), while no significant relationship appeared with other games.

As for the (PWC170) test, it showed a strong relationship with the level of performance of serving in badminton and squash, as their values reached (0.997) and (0.991), respectively [6].

In the last test (VO_2Max), only a correlation relationship appeared between the performance of serving and this test in tennis only, as the calculated correlation value was (0.979), which is greater than the tabular value of (0.878) under a degree of freedom (3) and a significance level of (0.05). While the rest of the values of the relationships between these tests and the level of skill performance of the research sample individuals were less than the tabular value, as shown in Table (4). The researcher attributes this to the fact that some players need aerobic capacity of (15%) to enable them to play throughout the match of all types without feeling tired.[7] The aerobic capacity tests that distinguished the sample individuals generally require endurance, but they are needed by players of activities characterized by speed, explosive power, and power characterized by speed, such as racket games, as they constitute an essential part of the general physical preparation that helps increase their endurance to perform high-intensity training doses.

Conclusion

1. The phosphagen capacity of racket players showed a significant relationship between the level of serving performance of squash players only.
2. The lactic capacity was at a varying level among racket players, as it was weak with the level of serving skill performance of squash players and badminton players, while it showed a strong relationship with the level of performance of tennis and table tennis players.
3. Strong correlations appeared between aerobic capacities in the (PWC170) test and serving skill for both badminton and squash players, while the VO_2Max index showed a high relationship with serving skill in tennis as well as in the Queen's test.
4. Most of the relationships between aerobic and anaerobic capacities of racket players are not significant, which indicates the presence of weakness in most of the energy production contributing to the performance of these players, as well as the presence of weakness in the application of exercises specific to developing these systems.
5. The level of lactic capacity and aerobic capacity in general for the four research groups were similar to them, as the differences for the tests of this capacity were not significant, meaning that the aerobic energy consumed during the actual performance was at one level of efficiency for the racket players.

Recommendations

1. The necessity of emphasizing the development of anaerobic lactic abilities and cyclic respiratory fitness in a manner that is consistent with the nature of performance for each of the racket games and in a way that achieves the functional efficiency required to perform the various skills.
2. There must be a link between aerobic and anaerobic training for racket players, as aerobic training constitutes the basic physical and physiological basis for them.
3. Emphasizing the necessity of applying physical exercises specific to developing the vital systems that contribute to energy production for racket players.
4. The necessity of conducting a periodic evaluation of the various aerobic and anaerobic abilities in order to correct training programs according to these indicators through physiological tests.

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