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The Effectiveness of Tabata-Style Training Exercises in Improving Cardiorespiratory Fitness and Selected Physical Abilities among Tennis Players Under 16 Years of Age

LUBNA ABDULRSOOL SHAKIR

lubna.a@uokerbala.edu.iq

Barakat Mohammed Ali Dheyaa

barakat.m@uokerbala.edu.iq

Ola Raheem Hasan

ola.r@uokerbala.edu.iq

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Abstract

This study aimed to investigate the effect of Tabata exercises on developing cardiorespiratory fitness and selected physical abilities among tennis players under 16 years of age. The experimental method, using a pre-test/post-test design with equivalent groups, was employed as it was appropriate to the nature of the research problem. The research population consisted of ten (10) tennis players under 16 years of age from Al-Durra Sports Club during the 2025 season. The research sample was selected using a census sampling method, whereby the entire research population constituted the sample. The sample was divided into two groups, a control group and an experimental group, with five players in each group. The researcher developed Tabata exercises, which were implemented during the special preparation period in the main part of the training session, specifically at the beginning of the main phase. During the first two weeks, the training protocol consisted of 15 seconds of work followed by 15 seconds of rest for eight repetitions, with a one-minute rest interval between sets. During the remaining weeks, the training load consisted of 20 seconds of work followed by 10 seconds of rest for five repetitions, with a one-minute rest interval between sets. The training intensity ranged from 85% to 90% of the maximum training intensity, using high-intensity interval training (HIIT). One of the key findings was that Tabata exercises had a positive effect on improving cardiorespiratory fitness among the research participants, as they effectively targeted the muscle groups involved in tennis performance.

Introduction:

The process of sports training contributes to athletes reaching high levels through the comprehensive development of all physical, functional, and skill-related aspects. This has led experts and specialists to search for modern and diverse methods that include training approaches supporting existing educational and training methods to enhance athletes' performance. Among these methods is mental training, which incorporates effective cognitive procedures and tools to positively influencekinetic performance.

Tennis is one of the individual sports that is characterized by the abundance of diverse defensive and offensive kinetic skills, in which players exert great effort during training or during matches. Players need integration of all physical and functional qualities and abilities. Physiological variables play an important role in the sports field, as they determine the player's abilities and the extent of his ability to continue performing physical exertion. Therefore, coaches must pay attention in their training programs and include special and varied exercises that require preparing tennis players to be distinguished by abilities that enable him to perform his skills with full effectiveness. One of these exercises is Tabata exercises, which are considered among the important exercises, as these exercises are performed at a high intensity, involving various muscle groups. Due to the special nature of tennis in terms of time and the nature of physical effort from serves, forehand and backhand strokes, speeds and different distances, the tennis player's good utilization of his functional and physical abilities and capabilities is the basic element to enhance and develop his level of performance. To fully utilize his skill potential, he needs to develop his physical abilities and improve the physiological aspects of cardiorespiratory fitness, as these are important indicators of an athlete's functional competence. Therefore,

the importance of this research lies in developing specific training programs based on the Tabata method and understanding their impact on the physiological and physical capabilities of young tennis players.

Research Problem:

Tennis is a sport that demands high levels of physical and physiological capabilities, which are crucial for skill performance. The researcher, a former national team tennis player, observed a clear weakness in physical abilities, particularly during extended matches. This suggests a lack of sufficient physical training to sustain performance and exert physical effort for longer periods. This may stem from insufficient attention to modern training methods, such as Tabata exercises, which are essential for developing physical and cardiorespiratory fitness, enabling athletes to maintain physical exertion for extended durations. Therefore, the researcher developed Tabata exercises and investigated their impact on the physiological and physical capabilities of tennis players under 16 years of age.

Research Objectives:

- To develop Tabata exercises for tennis players under 16 years of age.
- To identify the effect of Tabata training on developing cardiorespiratory fitness and some physical abilities in tennis players under 16 years of age.

Research Hypothesis:

- There is a positive effect of Tabata training on developing cardiorespiratory fitness and some physical abilities in tennis players under 16 years of age.

Research fields:

- Human field: Players of the Durrat Karbala Sports Club for the 2024-2025 training season.
- Time field: (19/6/2025) to (1/8/2025)
- Spatial field: The tennis court at the Durrat Karbala Sports Club and the laboratory of the College of Physical Education and Sports Sciences – University of Karbala.

Terminology

Tabata exercises: These are a form of high-intensity interval training (HIIT), consisting of eight rounds (repetitions) of high-intensity exercises in a period of 20 seconds of work and 10 seconds of rest. It may only take four minutes to complete a Tabata circuit, but those four minutes may push your body to its limit. (Emberts et al.,2013).

Research Methodology and Field Procedures:

Research Methodology:

The experimental method was used with a pre-test/post-test approach using equivalent groups, as it was suitable for the research problem.

Research Population and Samples:

The research population consisted of ten (10) tennis players under the age of 16 at the Durrat Karbala Sports Club for the 2025 season. The research sample was selected using a census method, meaning the sample represented the entire research population. The sample was divided into two groups (control and experimental), with five (5) players in each group.

Equipment and Tools Used in the Research:

- Observation.
- Testing and Measurement.
- One (1) Fitmate Pro device, German made.
- One (1) Trademail device, German made.
- One (1) Sony video camera, Japanese made.
- Manual sensor.
- Measuring tape.
- Obstacles of varying heights
- Casio electronic timer (Japanese made)
- tennis balls
- Tennis rackets

Description of the Tests Used in the Research:

First: Bruce Test for measuring cardiorespiratory fitness (GhassanBahriShamkhi. 2012)

- Equipment and Tools: Fitmate Pro device using a treadmill.
- Procedure Description: The subject's data is entered into the Fitmate Pro device, as required, and then the cardiorespiratory fitness test is selected.
- The subject performs a short warm-up on the treadmill (treadmill) by controlling the speed for (3-5) minutes before performing the actual test.
- The subject gets on the treadmill (treadmill) and then puts on the heart rate monitor and the VO2max mask for the Fitmate Pro device.
- The treadmill is started, followed by the Fitmate Pro device, which has been pre-set to the VO2max test.

- Here begins Bruce's method of performing progressive exertion, as the person conducting the test promises to increase the speed and incline of the treadmill every three minutes (increase the intensity every three minutes), and the tester continues to perform until the exertion is exhausted, and then presses the end button for the treadmill and the Fit mate pro device.

- Scoring: The result is calculated based on the VO2max value measured in milliliters per kilogram per minute (ml/kg/min) by the device.

Second: Explosive Power Test of the Arms (Muhammad SubhiHassanin and Hamdi Abdel Moneim, 1998).

- From a standing position, throw a 3 kg medicine ball forward with both hands overhead.

- Purpose of the test: To measure the explosive power of the arm muscles.

- Equipment needed measuring tape, 3 kg medicine ball, whistle to signal the start, chalk.

- Performance description:

- The athlete stands with their feet shoulder-width apart behind the throwing line drawn on the floor, holding the medicine ball in front of their chest.

- The starting signal is given to the athlete, who then throws the medicine ball forward as far as possible.

Test instructions:

- The athlete must assume the correct position (standing with their feet shoulder-width apart) with the medicine ball in front of their chest.
- The athlete must not touch the line drawn on the floor.
- The athlete must not lift their feet off the ground during the performance.
- Perform an arc with your back, bringing the medicine ball backward with your arms, and then throw it forward as far as possible.
- Speed of execution.
- Each player has two attempts; the best one is recorded.
- The score achieved by each player is announced to the next player to ensure a competitive environment.
- Scoring: The distance, in meters and fractions thereof, is measured and recorded for each player from the throwing line to the point where the medicine ball lands.

Third: Leg Muscle Strength Endurance Test (Full Standing Bend for 60 Seconds) (Ali Salman Abdul Tarfi ,2013.)

- Purpose of the test: To measure the strength endurance of the leg muscles.

Equipment needed:

- Electronic stopwatch and whistle.
- Recorder: To record the number of repetitions (full leg bending and extension, counting the number in 60 seconds).
- Timer: To give the start and end signals, time the repetitions, and observe the accuracy of the test and count.
- Performance: From a standing position, fully bend and extend the legs, counting the number in 60 seconds.
- Test instructions: Full knee bending and extension. Each player is given only one attempt.

- Recording: Count the number of correct repetitions (full knee bending and extension) for 60 seconds.

Fourth: The Fast Arm Power Test. (YassineNaji, Bastawisi Ahmed. 1987)

- The forward-leaning push-up test for (10) seconds.

- Test Purpose: To measure the fast power of the arm and shoulder muscles.

- Scoring Method: The number of correct push-ups within (10) seconds is counted for the player performing the test.

Exploratory Test:

The Exploratory test was conducted on a sample of (3) players from outside the research sample on June 19, 2025, at the tennis court in Al-Durra Sports Club in the Holy Karbala Governorate. Its objectives were:

- To verify the validity of the methods used when administering the test.

- To ensure the clarity of the test instructions and the players' understanding of their application.

• To assess the suitability of the test duration.

Pre-Tests:

The pre-tests were conducted from June 21-22, 2025, at 6:00 PM in the laboratory of the College of Physical Education and Sports Sciences, University of Karbala, and at the Al-Durra Sports Club in Karbala Governorate, as follows:

Day 1: Cardiorespiratory Fitness Measurement: The pre-test for this variable was conducted at 6:00 PM in the laboratory of the College of Physical Education and Sports Sciences, University of Karbala. Measurements were taken from both the experimental and control groups, totaling 10 players, and the data were recorded for statistical analysis.

Day 2: Physical Abilities Measurement: This took place at 6:00 PM on the tennis court at the Al-Durra Sports Club in the holy city of Karbala.

Homogeneity and Equivalence of the Research Sample:

Honorability and equivalence were established between the two groups in the tests administered to the players in the Exploratory study, as shown in Table (1) and Table (2).

Table (1) shows the homogeneity of the sample

No.	Variables	Measuring unit	value(Leven)		Level Sig	Type Sig
			calculated	sig		
1	Height	cm	1,342	0,444	Non-sig	homogeneity
2	Mass	kg	0,887	0,297	Non-sig	homogeneity
3	Chronological Age	year	0,129	0,892	Non-sig	homogeneity
4	Training Age	year	1,093	0,889	Non-sig	homogeneity

Table (2) represents the equivalence between the research sample and the researched variables

Variables and Measurements	Unit of Measurement	Experimental group		Control group		T value		Type Sig
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation	calculated	Sig	
Cardiorespiratory fitness	ml L/kg min	38.130	1.043	38.070	1.514	0.073	0.944	Non-sig
Explosive Power Test of the Arms	m	3,888	1,789	3.787	1.898	1.874	0.222	Non-sig
Fast Arm Power	number	7.797	2.777	6.956	2.343	1.654	0.132	Non-sig
Leg Muscle Strength Endurance	number	45.400	1.140	45.200	1.303	0.258	0.803	Non-sig

Tabata Exercises Developed by the Researcher:

After reviewing available scientific sources and consulting with several experts and specialists in the field of sports training and tennis, the researcher developed his Tabata exercises. The details of the exercises are as follows:

1- The exercises were performed during the specific preparation period.

2- The researcher determined the number of weekly training sessions to be two sessions on Sundays and Tuesdays, totaling 16 training sessions.

3- A portion of the main section of the training session was used, specifically the beginning of the main section.

4- The training cycle for the first two weeks consisted of 15 seconds of work followed by 15 seconds of rest after 8 repetitions, with a one-minute rest period between sets.

5- The training cycle for the remaining weeks consisted of 20 seconds of work followed by 10 seconds of rest, with 5 repetitions and a one-minute rest period between sets.

6- The duration of each training session is 24-30 minutes.

7- The intensity used ranges from 85-90%.

8- The training method used is high-intensity interval training.

Main Experiment:

The main experiment was conducted on the experimental group, consisting of 5 players, from June 25, 2025, to August 25, 2025.

Post-Tests:

The post-tests were conducted on August 27-28, 2025, under the same conditions as the pre-tests, and the results were confirmed.

Statistical Methods Used in the Research:

The researchers used the SPSS statistical package to verify the research data.

Presentation, Analysis, and Discussion of Results:

Presentation and Analysis of Results:

Presentation and Analysis of Pre- and Post-Test Results for the Experimental and Control Groups:

Table (3) Shows the means for the pre- and post-tests for the experimental and control groups and the calculated t-values

Variables	Groups	Pre-test		Post-test		T value	Level Sig	Type Sig
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
Cardiorespiratory fitness	Experimental	38.130	1.043	41.960	1.177	15.55	0.000	Sig
	Control	38.070	1.514	38.126	1.519	4.106	0.015	Sig
Explosive Power Test of the Arms	Experimental	3,888	1,789	5.887	1.887	9.564	0.000	Sig
	Control	3.787	1.898	4.823	2.983	5.866	0.000	Sig
Fast Arm Power	Experimental	7.797	2.777	13.854	3.675	8.876	0.000	Sig
	Control	6.956	2.343	10.665	2.987	6.897	0.000	Sig
Leg Muscle Strength Endurance	Experimental	45.400	1.140	54.400	5.224	3.674	0.021	Sig
	Control	45.200	1.303	46.600	1.516	5.715	0.005	Sig

Presentation and Analysis of Post-Test Results for Experimental and Control Groups

Table (4) shows the means for the post-tests of the experimental and control groups, the calculated t-value, and its statistical significance for the tested tests

Variables and Measurements	Experimental group		Control group		T value	Level Sig	Type Sig
	Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
Cardiorespiratory fitness	41.960	1.177	38.126	1.519	11.973	0.000	Sig
Explosive Power Test of the Arms	5.887	1.887	4.823	2.983	5.903	0.000	Sig
Fast Arm Power	13.854	3.675	10.665	2.987	7.992	0.000	Sig
Leg Muscle Strength Endurance	54.400	5.224	46.600	1.516	4.823	0.000	Sig

Discussion of Results:

By examining the results in Tables (3 and 4), we find an improvement in the results of the variables under investigation for both the experimental and control groups in the post-test compared to the pre-test.

This indicates that the training program developed by the researcher (Tabata training) had a positive impact on the studied variables. Generally, the sports training references we have cited emphasize the necessity of planning the training program to achieve objectives that translate into observable and measurable performance, which is precisely what the researcher strived to achieve.

The researcher attributes the improvement achieved by the experimental group in the post-test to the nature of the Tabata exercises, which the researcher prepared based on well-studied scientific principles in order to enhance specific endurance capabilities, as Tabata exercises play a major role in developing strength endurance.

"training based on the gradual increase in training load from one training unit to another, with an appropriate increase, will lead to the appropriate muscular adaptation to this increase, which leads to an improvement in strength endurance. Therefore, the trainee must set specific goals for his capabilities." (Adel Turki Hassan Al-Dalawi. 2011)

This is what confirmed: Tabata training, which consists of very high-intensity repetitions with short rest periods, is a very challenging physical exercise and is used to develop anaerobic abilities. (Foster, et al, 2015)

The researcher also attributes the improvement observed in the control group in the post-test to the players' continued training with the coach's exercises, which aimed at strength endurance. Continuous, programmed training develops specific physical abilities and brings performance times up to competitive levels. The training load must be programmed to

develop strength endurance by linking physical exercises with skill-based drills to raise the training level. (Amer Fakher Shaghati,2011)

The researcher attributes this improvement to the exercises he developed, which were meticulously prepared based on studies, research, and other sources. From the outset, the researcher considered the principle of organizing these exercises and implementing them within training units. This allows for the structured training of the specific skill to align with the desired objective. (Tariq Mohammed Abdul Raouf,1998)

The principle of progression from easy to difficult and from simple to complex is also employed. This progression ensures regular coordination and connection between the exercises used in the training unit, with their intensity and volume increasing progressively according to the player's training level. (Qasim Hassan, Mahmoud Abdullah,1987)

Tables (3) and (64) clearly show significant differences between the pre-test and post-test for the two research groups (control and experimental). This indicates an improvement in the cardiorespiratory fitness variable, favoring the post-test for both groups. The researcher attributes the improvement in the experimental group to the nature of the Tabata exercises, which were applied scientifically and systematically. For tennis players who exert physical effort during training and matches, cardiorespiratory fitness is a fundamental requirement that must be considered when designing training units and exercises. Therefore, we emphasize the necessity of developing this physiological variable through training. A two-month training period is sufficient to increase a player's ability to perform tasks at maximum capacity. This is what the researcher was able to achieve through the exercises designed for the experimental group. These exercises played a role in promoting regular training, which led to adaptation in the respiratory system and increased its efficiency. This, in turn, improved the muscular system's ability to extract oxygen,

thus increasing its capacity for increased consumption. Confirmed that the high-intensity interval training protocol used in Tabata training principles is a time-efficient training protocol that can be safely used to induce physiological responses to improve circulatory-respiratory and metabolic functional fitness. (Williams & Kraemer, 2015)

Conclusions and Recommendations:

Conclusions:

- Tabata exercises had a positive effect on improving cardiorespiratory fitness among the research participants because they targeted the working muscles of tennis players.

- Tabata exercises had a positive effect on developing physical abilities among the research participants because they targeted the working muscles of tennis players.

- Tabata exercises helped break the training routine, leading to improved results.

- Tabata exercises contributed to reducing training time.

Recommendations:

According to the researcher's conclusions, which demonstrated the effectiveness of using Tabata exercises, the researcher recommends the following:

- The researcher recommends focusing on using Tabata exercises according to scientific training principles to enhance the anaerobic efficiency of tennis players during matches. - Conduct similar studies using Tabata training for other sports that require speed, strength, power, and endurance.

- Conduct similar studies on samples of different age groups to develop the physical abilities important for tennis players.

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Appendix (1)

Exercises Used in the Research:

1- Lateral Jump: From the starting position, jump upwards over the cone to the other side, then jump to the other side, and so on, while pulling the knees.

2- Medicine Ball Throw from a Seated Position: Two players sit facing each other. One player holds the ball to their chest and begins the exercise by passing it to the other player, who then returns the pass, and so on. The ball is thrown with both hands (chest pass), using the glutes, abdominal muscles, and arm muscles.

3- Jumping forwards over cones (30-40 cm) continuously with both feet, emphasizing upward jumps. There are 10 cones.

4- Jumping off Swedish benches (40-50 cm) and landing on the ground with both feet continuously.

5- Jumping forwards over hurdles (50 cm) with both feet, keeping the body vertical while swinging the arms to achieve the desired height.

6. Medicine Ball Throw: The player throws a medicine ball (weighing 3 kg) upwards and catches it.

1- From a forward support position, perform the exercise for 30 seconds upon hearing the coach's whistle.

2- Reactive Ball Drill: Throw a reaction ball to the ground and attempt to catch it quickly.

3- Jump Rope Drill.

4- Perform the serve using a weighted racket.

5- The player moves laterally between two points, right and left, and at each stop performs a quick forehand or backhand shot.

Appendix (2)

Sample training unit from the first week

Units	Exercise	Intensity %	Repetitions (time) (sec)	Repetitions	Rest between repetitions(sec)	Sets	Total time(minute)
First	Third	%85	15	8	15	1	4
	Seventh	%90	15	8	15	1	4
	Ninth	%85	15	8	15	1	4
Second	First	%85	15	8	15	1	4
	Fourth	%90	15	8	15	1	4
	Eighth	%85	15	8	15	1	4