The effectiveness of special exercises using an assistive device on reaction speed, shoulder joint angle, and learning the skills of serving and forehand stroke in tennis for students

La eficacia de ejercicios especiales con un dispositivo de asistencia sobre la velocidad de reacción, el ángulo de la articulación del hombro y el aprendizaje de las habilidades de saque y golpe de derecha en tenis para estudiantes

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How to cite in APA

Mhmood Sabea, N., Abdalkarem, A. A., Yahya Albayati, S. R., & Awadh Alshaher, I. S. (2025). The effectiveness of special exercises using an assistive device on reaction speed, shoulder joint angle, and learning the skills of serving and forehand stroke in tennis for students. *Retos*, *70*, 1360–1367. https://doi.org/10.47197/retos.v70.117012

Abstract

Objective: Prepare special exercises to develop exercises using an assistive device to develop reaction speed, shoulder joint angle, and students' ability to perform the serve and forehand stroke in tennis, and identify the effect of exercises using an assistive device on developing reaction speed, shoulder joint angle, and students' ability to perform the serve and forehand stroke in tennis.
Research methodology: The researcher relied on the experimental approach, given its compatibility with the nature of the research used a two-group design, an experimental and a control group, with a pre-test and a post-test, the research community consisted of 95 third-year students at the Islamic University. Thirty students were selected as the research sample, constituting 31.57% of the total research community.
Results: The results) showed significant differences between the pre- and post-tests. The results were in favor of the post-tests. The control group, which received instruction using the traditional method adopted by the subject teacher, showed limited development in the study variables (such as reaction speed, serve accuracy, and forehand strike).
Conclusions: The exercises using the assistive device demonstrated a clear positive effect on developing students' reaction speed compared to the control group, which used the traditional method, and the exercises contributed to improving shoulder joint mobility in terms of angle and range of motion, which was reflected in the quality of skill performance.

Keywords

Special exercises; reaction speed; shoulder joint angle; serving; forehand stroke; tennis.

Resumen

Objetivo: Preparar ejercicios especiales con un dispositivo de asistencia para desarrollar la velocidad de reacción, el ángulo de la articulación del hombro y la capacidad de los estudiantes para realizar saques y golpes de derecha en tenis, e identificar el efecto de los ejercicios con un dispositivo de asistencia en el desarrollo de la velocidad de reacción, el ángulo de la articulación del hombro y la capacidad de los estudiantes para realizar saques y golpes de derecha en tenis.
Metodología de la investigación: El investigador se basó en un enfoque experimental, dada su compatibilidad con la naturaleza de la investigación. Se empleó un diseño de dos grupos: un grupo experimental y un grupo control, con un pretest y un postest. La comunidad de investigación estuvo compuesta por 95 estudiantes de tercer año de la Universidad Islámica. Treinta estudiantes fueron seleccionados como muestra de investigación, lo que representa el 31,57% del total de la comunidad de investigación.
Resultados: Los resultados mostraron diferencias significativas entre el pretest y el postest. Los resultados fueron favorables para el postest. El grupo control, que recibió instrucción mediante el método tradicional adoptado por el profesor de la asignatura, mostró un desarrollo limitado en las variables de estudio (como la velocidad de reacción, la precisión del saque y el golpe de derecha). Conclusiones: Los ejercicios con el dispositivo de asistencia demostraron un claro efecto positivo en el desarrollo de la velocidad de reacción de los estudiantes en comparación con el grupo control, que utilizó el método tradicional, y los ejercicios contribuyeron a mejorar la movilidad de la articulación del hombro en términos de ángulo y rango de movimiento, lo que se reflejó en la calidad del desempeño de la habilidad.

Palabras clave

Ejercicios especiales; velocidad de reacción; ángulo de la articulación del hombro; saque; golpe de derecha; tenis.

Introduction

The primary goal of teachers and coaches is to enhance students' learning and develop athletes' performance. This is achieved by improving their skills and mastering their learning. This relies on the use of advanced educational and training strategies and methods, along with effective training organization through varied repetitions. Each training method has its own goals and requirements, requiring careful scheduling, practical training, and optimal repetition distribution. (Madloul et al., 2025)

To achieve the goals and aspirations of the educational process, research experiments should be conducted to select the most appropriate exercises and determine their practice periods and repetitions to suit the learners' level and abilities. Appropriate rest periods should also be incorporated within the training, making maximum use of the available resources in the educational environment. (Saleem Radhy et al. 2025)

Reaction speed is a key element required by most athletes, especially in individual sports. In tennis, the nature of tactical skills, both offensive and defensive, along with the size of the court, speed of performance, and movement between positions, requires a player to possess a high capacity for reaction speed. This enables them to keep up with their opponents both offensively and defensively, enhancing their chances of scoring points quickly and winning the match with the least possible effort. In this way, the player maintains their physical fitness for the longest possible time during each game. (Shaker et al., 2022). Tennis is an individual sport that combines opportunities for practice, competition, and entertainment. It has witnessed significant development thanks to the efforts of many experts and interested parties who have devoted themselves to studying its various aspects using scientific methods, with the aim of improving the physical, skill, and psychological levels of young players, and enabling them to reach the highest levels of performance and achieve outstanding accomplishments (Shaalan et al., 2022)

Hence, the importance of this research lies in its aim to introduce modern training methods based on an assistive device specifically designed to develop some important physical and abilities in tennis, specifically reaction speed and shoulder joint angle, which are factors that directly influence the efficiency of skill performance. The importance of the research also lies in its contribution to accelerating and facilitating the learning of basic skills such as the serve and forehand among students, opening new horizons for teachers and coaches to use innovative training devices and techniques. Furthermore, the research provides scientific support for training programs that aim to link physical development with skill learning within an organized academic framework.

Research problem

Tennis is a sport that requires precise skills and quick reaction, in addition to proficiency in performing basic movements, such as the serve and forehand. Through the researcher's observation of the students' performance and his knowledge of the training environment, it was revealed that there is a weakness in reaction speed and shoulder joint movement angle, which negatively impacts the learning of these skills. Furthermore, traditional teaching methods may not be sufficient to stimulate the desired development in a short period. Hence, the research problem is defined in the following question:

Do exercises using an assistive device contribute to developing reaction speed and shoulder joint angle, and improve students' learning of the serve and forehand skills in tennis?

Research objective

- Prepare special exercises to develop exercises using an assistive device to develop reaction speed, shoulder joint angle, and students' ability to perform the serve and forehand stroke in tennis.
- Identify the effect of exercises using an assistive device on developing reaction speed, shoulder joint angle, and students' ability to perform the serve and forehand stroke in tennis.

Research hypotheses

- There is a positive effect of exercises using an assistive device on developing reaction speed, shoulder joint angle, and students' ability to perform the serve and forehand stroke in tennis.

Research fields

- Human field: Third-year students at the College of Physical Education at the Islamic University
- Time field: (10/3/2025) to (28/4/2025)
- Spatial field: tennis court within the college

Method

Research Methodology

The researcher relied on the experimental approach, given its compatibility with the nature of the research used a two-group design, an experimental and a control group, with a pre-test and a post-test. This design is considered an experimental design based on measuring the variables of the experimental group beforehand, introducing an independent variable, and then re-measuring them afterward. To determine the significance of the differences between the arithmetic means of the pre- and post-tests, the researcher used the t-test for correlated samples.

Community and sample research

The process of selecting a sample is closely related to the nature of the community from which the sample is drawn. The sample is considered part of the community on which the tests are conducted and aims to accurately represent it.

The research community consisted of 95 third-year students at the Islamic University. Thirty students were selected as the research sample, constituting 31.57% of the total research community.

Sample Homogeneity

To ensure the homogeneity of the research sample and control for variables that might affect the accuracy of the results, the researcher examined the sample homogeneity through a set of variables related to anthropometric and morphological measurements. These variables included: mass, height, and chronological age. The researcher relied on the skewness coefficient to analyze the data, and the results are shown in Table (1).

Table 1. Shows the statistical parameters: the arithmetic mean, standard deviation, median, and skewness coefficient for the variables.

Variables	Measuring unit	Mean	Std. Deviations	Median	Skewness
Mass	Kg	69.22	7.33	68	-0.487
Length	Cm	172.4	4.21	172	0.284+
Chronological age	Year	21.20	1.72	21	0.116-

Since the results of the skewness coefficient were all between (+1), the research sample members were homogeneous in terms of the aforementioned variables.

Methods, Devices, and Tools Used

Data Collection Methods

- Arabic and foreign sources and references.
- Personal interviews.
- Questionnaire.
- Observation.
- Tests and measurements.

Devices and Tools Used

- Tennis court.
- (3) High-resolution cameras.

- (6) Indicators.
- (50) Tennis balls.
- Basketball basket.
- (15) Tennis rackets.
- (4) Colored adhesive tape.
- Blackboard, (10) chairs.
- Office supplies (papers and pens).

Field Research Procedures

Tests Developed for Research Variables

First: Reaction Speed Test (Abdel-Sattar, 2019)

- Test Name: Reaction Test Using a Light Ball Device
- Test Purpose: It aims to measure the speed of visual and muscular reaction in tennis players when confronted with a sudden stimulus, such as a suddenly released ball or an unexpectedly appearing light.
- Performance Method:
  - The player stands behind the baseline on the court.
  - A special device is used that randomly releases a light or mechanical ball from one of four directions: forward, backward, right, or left.
  - The player must respond immediately, moving toward the ball and attempting to touch or block it.
  - The time between the appearance of the ball and the moment the player responds is measured.
- Number of attempts: Ranges from 5 to 10 attempts, with the fastest reaction and average time used as basic performance indicators.
  - Second: Variable shoulder joint angle
  - The right shoulder joint angle in the main part: is the angle between the humeral line (from the point of the elbow joint to the point of the shoulder joint) and the torso line (from the point of the shoulder joint to the point of the hip joint).
  - Third: Tennis Service Accuracy Test. (Hassan, 2010)
  - Test Name: Tennis Service Accuracy Test
- Test Objective: Measure accuracy and consistency in serving toward specific areas within the service box.
- Test Method:
  - The student stands behind the service line (baseline).
  - They are required to execute 10 legal serves with their right or left hand toward the opposite service box.
  - The service box is divided into three target areas:
  - The outside corner.
  - The center of the box.
  - The inside corner.
  - The student is awarded one point for each successful serve in the required area.

- Points are totaled from 10 attempts.

Fourth: Forehand Skill Test (Al-Shazly, 2013)

Test Name: Forehand Groundstroke Accuracy Test

- Objective of the test: To measure the accuracy and consistency of the forehand stroke towards specific areas on the tennis court.
- Method of Performance:
  - The student stands at the center of the baseline.
  - The ball is fed to the student by a coach or a ball launcher, towards the right side (the forehand stroke location).
  - The student executes 10 consecutive forehand strokes.
  - The court is divided into target zones within the opponent's half of the court (usually three zones: length, depth, and center).
  - One point is awarded for each shot that hits the desired zone (accurately targeted), and zero for an error or out.

Exploratory Experiment

The researcher conducted an exploratory experiment related to the research variables on Monday, March 17, 2025, with the participation of four third-year students from outside the research sample. This experiment aimed to determine the time required to complete the tests and the feasibility of their subsequent application to the research sample. It also explored any obstacles that might arise during the implementation of the tests in the main experiment.

Main Experiment

The researcher prepared and organized special exercises using a device designed by the researcher (Ali et al., 2021). The researcher prepared his own exercises on the device based on his personal experience, in addition to benefiting from the opinions of experts and specialists he gathered through personal interviews in the fields of (sports training, learning, and tennis). The researcher began implementing these exercises on the research sample from March 19, 2025, to April 21, 2025, taking into account the components of the training load. The specific exercises were scientifically designed, taking into account the physical abilities of the sample and the tools used, with the goal of improving reaction speed and learning the skill performance of the tennis serve and forehand skills for students, thus contributing to achieving the objectives of the training and educational process.

Post-test Measurements

The researcher conducted post-tests on the research sample after completing the specific exercises on the device, under his direct supervision, to measure the extent of the sample's development. The tests were conducted on Tuesday, April 22, 2025, on the college's tennis court, after completing the specific exercises. The researcher ensured that the conditions were the same as those available during the pre-tests to ensure the accuracy of the results.

Statistical Methods

The researcher used the Statistical Package for the Social Sciences (SPSS) for statistical processing.

Findings

Presentation and discussion of the study results on the variables studied for the control group:

Table 2. Shows the results of the skill tests for the control group.

Variables	Measuring unit	Pre-test		Post-test		T value	Level Sig	Type Sig
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			

Reaction Speed	Sec	0.88	0.784	0.79	0.884	3.922	0.022	Sig
shoulder joint angle	Degree	64	1.232	60.5	0.926	4.604	0.012	Sig
serving skill	Degree	4.5	1.856	6.2	1.244	4.033	0.003	Sig
Forehand Skill	Degree	5.2	2.033	6.4	1.278	2.028	0.022	Sig

Presentation and discussion of the study results on the variables studied for the experimental group:

Table 3. Shows the results of the skill tests for the experimental group.

Variables	Measuring unit	Pre-test		Post-test		T value	Level Sig	Type Sig
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
Reaction Speed	Sec	0.84	0.766	0.74	0.822	5.041	0.008	Sig
shoulder joint angle	Degree	66	1.276	58.2	1.045	3.773	0.004	Sig
serving skill	Degree	4.8	1.256	6.8	1.141	4.206	0.005	Sig
Forehand Skill	Degree	5.9	1.446	7.2	1.288	6.117	0.000	Sig

Presentation and discussion of the results of the post-tests on the studied variables for the control and experimental groups:

Table 4. Shows the results of the skill tests for the control and experimental groups in the post-tests.

Variables	Measuring unit	Control group		Experimental group		T value	Level Sig	Type Sig
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
Reaction Speed	Sec	0.79	0.884	0.74	0.822	4.221	0.004	Sig
shoulder joint angle	Degree	60.5	0.926	58.2	1.045	9.342	0.000	Sig
serving skill	Degree	6.2	1.244	6.8	1.141	2.124	0.012	Sig
Forehand Skill	Degree	6.4	1.278	7.2	1.288	2.942	0.017	Sig

Discussion

The results in Table (2) showed significant differences between the pre- and post-tests. The results were in favor of the post-tests. The control group, which received instruction using the traditional method adopted by the subject teacher, showed limited development in the study variables (such as reaction speed, serve accuracy, and forehand strike).

This is attributed to the fact that traditional methods often focus on theoretical explanation and repetition without enhancing the sensori factor or diversifying the stimuli, which may weaken the student's motivation and reduce the effectiveness of the adaptive reaction. Some studies, such as have indicated that relying solely on traditional methods may lead to slow and unstable improvement in skill acquisition, especially in sports that rely on speed, accuracy, and anticipation, such as tennis (Hassan, 2010). This is consistent with the results of this group, which recorded only slight improvement in serve accuracy and reaction speed, but this did not reach the level of the experimental group that used modern exercises or assistive devices. The results presented in Table (3) for the tennis reaction speed and skill tests also showed significant differences between the pre- and post-measurements, with the results favoring the post-measurements for the experimental group. Given the distinctive nature of tennis, which relies heavily on speed movements and immediate reactions, especially the forehand stroke, a specially designed device was used to measure reaction speed. In addition, the device offers specific exercises, both with and without it, aimed at developing the physical abilities necessary to improve students' forehand performance. These exercises were designed according to the stages of reaction speed, taking into account the appropriate time periods for training. The researcher attributes the significant differences in reaction speed to the diversity of qualitative exercises that focused on random visual stimuli using multiple means, whether with or without the designed device. These exercises aim to improve visual inputs and develop reaction and reaction speed. This is especially true since tennis relies heavily on reaction speed and responding to speed movements in light of the ball's high speed launch, which requires a very precise and speed reaction. Therefore, the researcher relied on specific exercises using a specialized device to measure reaction speed as an auxiliary tool, while reducing the stimulus's launch distance to more effectively simulate game conditions. This indicates that repetition of interactive situations similar to real-life play contributes to accelerating neuromuscular conduction and improving decision-making speed. (Brebner & Welford 1990) indicated that the use of diverse and surprising stimuli

during training enhances the efficiency of the central nervous system and reduces the time between stimulus appearance and reaction. This was clearly reflected in the statistical results of the group trained on the modern exercises.

Regarding the development of the variable (shoulder joint angle) among the experimental group, the researcher believes that the reason behind these differences is due to the students' great commitment to following the specific exercises and their strong desire to improve their performance in this skill. These exercises helped correct the angles of the variables and bring them closer to the model angles through immediate feedback. The exercises also featured the use of a device designed as an aid to developing bio-kinematic variables, as this device works to improve the correct paths for the forehand strike.

Conclusions

- The exercises using the assistive device demonstrated a clear positive effect on developing students' reaction speed compared to the control group, which used the traditional method.
- The exercises contributed to improving shoulder joint mobility in terms of angle and range of motion, which was reflected in the quality of skill performance.
- There was a significant improvement in the level of mastery of the serve and forehand skills among the experimental group.
- Training using assistive devices increased students' motivation to learn and created a stimulating and interactive training environment.
- The traditional method alone is insufficient to achieve significant progress in fine skills in tennis.

Recommendations

- Incorporate special exercises supported by assistive devices into the training and educational curricula for tennis.
- Direct physical education teachers to use modern training methods and techniques to develop sensory and abilities.
- Incorporate educational and assistive devices into university student preparation programs to improve the learning of basic sports skills.

Acknowledgements

None.

Financing

None.

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