ZAC Conference Series: Social Sciences and Humanities
(ZACCS: SSH)
https://conf.zenithacademic.co.uk/index.php/zacsssh
ISSN (Print): 3049-7760 ISSN (Online): 3049-7779
3rd International Humanitarian Conference, Baghdad 2024
Volume 001, Issue 01, 2024, pp. 001-137
https://doi.org/10.70516/zaccsssh.v1i1.31

The Effect of Special Exercises for The Arm at Different Angles Using Rubber Ropes Distinguished by The Speed, Speed and Accuracy of The Front Spiral for Table Juniors in Sweden

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Abstract. The science of sports training always seeks to raise the level in various sports activities in general and in table tennis in particular through the use of scientific methods in the training process, which constitute the cornerstone in developing physical abilities and skill performance. Special exercises contribute significantly to the development of physical abilities and the speed of skill performance, especially in the forward spiral strikes, by following the path of the arm movement, the type of rotation, and the speed of the stroke. Also, the type of hit executed and the player's distance from the table will largely determine the angle of the playing arm, and the position of the arm angle must be according to the goal of the hit. Coaches stress the importance of the arm angle at the moment the ball is struck to the player near the table being (90) degrees at Almost attached. From here, the research problem crystallized, as it was observed that there was a decrease in the level of performance of the skill of the forward spiral strike close to the table and at an angle of approximately (90) degrees, which is considered very important for the player when he faces a spiral strike close or far from the table from the opponent. The reason for this is attributed to the fact that most players do not They realize the importance of the relationship between the player's stance at the table and the angle of the striking arm, that is, not employing and investing in the mechanical foundations related to the angle of the striking arm. The researchers used the descriptive and experimental approach by designing the two groups with a pre-post measurement system for the occasion and nature of the study, cinematography, and analysis of bio-kinematic variables using the Kinovea program. The research sample was chosen intentionally from a team from the Swedish club IFK Lund Bord tennis under the age of 16 years. The most important results that were reached were For her; The positive effect of exercises using rubber ropes on developing strength characterized by speed, as well as the speed and accuracy of the ball in the post-tests of the experimental group compared to the control group. The researchers have made several recommendations, including conducting similar research through which the player's ability to develop how to invest physical and biomechanical abilities in other skills in the sport of table tennis can be developed. The researchers used the descriptive and experimental approach by designing the two groups with a pre-post measurement system for the occasion and nature of the study, cinematography, and analysis of bio-kinematic variables using the Kinovea program. The research sample was chosen intentionally from a team from the Swedish club IFK Lund Bord tennis under the age of 16 years. The most important results that were reached were For her; The positive effect of exercises using rubber ropes on developing strength characterized by speed, as well as the speed and accuracy of the ball in the post-tests of the experimental group compared to the control group. The researchers have made several recommendations, including conducting similar research through which the

player’s ability to develop how to invest physical and biomechanical abilities in other skills in the sport of table tennis can be developed

Keywords: Training, Biomechanics, Rubber Ropes, Table tennis.

CHAPTER 1

INTRODUCTION AND RESEARCH PROBLEM

The science of sports training consistently strives to enhance performance levels across various sports activities in general, and specifically in table tennis, through the application of scientific methods in planning and training. These methods constitute the cornerstone in the development and enhancement of physical capabilities and skill performance.

Researchers argue that training in table tennis is increasingly specialized to enhance and develop specific physical capabilities and skill performance of players. Moreover, the timing and type of training are crucial aspects. Additionally, the role and importance of biomechanical analysis enable understanding the application of mechanical laws in executing table tennis strokes. Analyzing performance and subsequently selecting appropriate exercises in the training process significantly contribute to improving stroke execution and achieving optimal results.

The forehand topspin strokes are considered fundamental attacking skills in table tennis, capable of significantly influencing match outcomes. These strokes are executed from various distances relative to the table, depending on the player's position. Consequently, players must execute the forehand topspin stroke with different arm angles determined by the distance from the table at the moment of execution. Furthermore, the angle of the playing arm determines the amount of ball rotation and speed.

And (Ali et al. 2019) mention that the hitting arm angle of less than or close to 90 degrees is primarily used for quick control shots. When the hitting arm angle exceeds this, specifically at three-quarters of the arm's angle, approximately 120 degrees, or a full arm angle of 180 degrees, they are used for powerful shots.

Additionally, both Kazim and Ali (2014) and Ahmed Abdullah (2007) emphasize that in order to win a point during table tennis matches, players must possess speed in their shots, the ability to direct the ball accurately, and precision in striking the ball to determine its placement on the table.

Hence, the research problem became evident, where a decline in the performance level of the near-table forehand topspin stroke at approximately a 90-degree angle was observed. This stroke is crucial for a player when facing either close or distant topspin strokes from their opponent. The reason for this decline is attributed to most players not understanding the importance of the relationship between their position relative to the table and the angle of the striking arm. That is, they fail to employ and capitalize on the mechanical principles related to the angle of the striking arm in a manner that ensures precision and appropriate speed to achieve the desired outcome, especially upon ball contact with the racket. Additionally, there is a deficiency in the speed characteristic specific to the arm holding the racket. Consequently, researchers have advocated for the development of specialized exercises utilizing elastic bands to enhance the speed characteristic of both arms and the speed and precision of the near-table forehand topspin stroke.

Research Objectives:

The research aimed to achieve the following:

1. 1. Designing specialized exercises for both arms using elastic bands and varying angles to enhance the speed characteristic of the arms, as well as the precision and speed of the near-table forehand topspin stroke.

2. Investigating the impact of these specialized exercises on the speed characteristic of the arms, and the speed and precision of the near-table forehand topspin stroke.

Research Hypotheses:

1. There are no statistically significant differences between pre-test and post-test measures of speed characteristic of the arms, and precision and speed of the near-table forehand topspin stroke in both control and experimental samples.

2. There are no statistically significant differences between the experimental and control samples in post-test measures of speed characteristic of the arms, and precision and speed of the near-table forehand topspin stroke.

Research Scope:

Human Field: Players representing IFK Lund Bordtennis Club, Sweden.
Temporal Field: Time period from 1 August 2022 to 4 February 2023.
Spatial Field: Sports hall of IFK Lund Bordtennis Club, located in Lund city, Sweden.

CHAPTER TWO

Field Research Procedures

Research Methodology

The researchers employed a descriptive and experimental approach utilizing a single-group pre-post measurement design suitable for the nature and objectives of the study.

2.2 Research Sample:

The research sample was purposively selected from junior players under 16 years old affiliated with IFK Lund Bordtennis Club and registered in the official records of the Swedish Table Tennis Association, totaling 12 players divided into control and experimental groups. Additionally, 4 players from outside the primary research sample were included for survey studies. Table (1, 2) demonstrates the homogeneity and equivalence among the individuals in the research sample.

Table (1) demonstrates the homogeneity of the research sample in terms of (chronological age, weight, height, and training age).

Variables	Measurements unit	Mean	Standard deviation	Median	Skewness Coefficient
Chronological age	**Year**	**14.5**	**3.34**	**14**	**0.66**
Height	**Cm**	**174**	**4.11**	**171**	**0.78**
Weight	**Kg**	**58**	**6.18**	**56**	**0.78**
Training age	**year**	**5**	**2.73**	**5.5**	**0.44**

Table 2 demonstrates the equivalence between the research groups in the study variables in the pre-tests.

Statistical Treatment	Measurement unit	Control Group		Experimental Group		Factorial Significance	Factorial Interaction	T value	sig
Variables		x	y	x	y				
the distinctive speed force Shnaou 10 seconds	**Number**	**6.83**	**0.753**	**7.50**	**0.548**	**-0.667**	**0.380**	**1.754**	**0.756**
Ball speed	**m/s**	**9.5**	**1.05**	**9.0**	**1.095**	**0.5**	**0.619**	**0.808**	**0.682**
Ball Accuracy	**Degree**	**9.33**	**0.816**	**9.17**	**0.753**	**0.167**	**0.453**	**0.368**	**0.646**

Research Tools

High-speed video camera (120 fps) of Kodak Play Sport type was used for recording. Kinovea software was employed for motion analysis. Additionally, elastic bands, table tennis balls, table tennis rackets, a table tennis table, and a ball launcher device (Table Tennis Robot Stag 989, D) were utilized.

Research Tests:

First: Speed-Specific Arm Strength (Sabehi Hassan, 1995)

Purpose of the Test: To measure speed-specific arm strength (10 seconds).

Test Procedure: The player assumes a semi-prone position. Upon receiving the starting signal, the player rapidly flexes and extends the arms as many times as possible within 10 seconds.

Recording: The number of correctly performed flexions and extensions by the player within 10 seconds is recorded.

Secondly: Accuracy and Speed Test of the Forehand Loop (Christiansson, 2003)

Purpose of the Test: To assess the accuracy of the forehand loop close to the table.

Tools Used: Table tennis table, ball throwing machine. The coach adjusts the ball throwing machine to deliver 10 controlled balls (control shots) alongside the backhand side of the table.

Test Procedure: The tester stands 1 meter away from the left side of the backhand table, assuming a ready position. The player returns 10 balls using the forehand loop with a 90-degree arm angle. Assistants stand close to the table as judges to observe and record the landing position of the ball. The player returns 10 balls using the forehand loop with a 90-degree arm angle: 5 balls to the forehand area and 5 balls to the backhand area of the table.

Scoring:

- Accuracy Calculation: The player receives 2 points when the ball lands in the intended area.
- The tester receives 1 point when the ball lands anywhere else on the table.
- The player receives no points if the ball goes out of the table.
- Each player makes two attempts, and the best attempt is selected.
- The player records the total score obtained from a total of 10 balls.

The ball speed was measured using a high-speed video camera (120 frames per second), placed on the left side of the table at a distance of 2 meters and a height of 1.10 meters above the ground to capture the speed of the ball from the moment it leaves the player's racket during the execution of the forehand loop until it touches the table surface. Kinovea software was used to measure the speed.

Survey Study

A survey experiment was conducted on Wednesday, September 1, 2022, at the sports hall of IFK Lund Bordtennis Club in Lund, Sweden, involving four table tennis players. The purpose of the study was:

- Adjusting exercises to fit the sample individuals.
- Calibrating and setting up the camera equipment used, determining the appropriate distance and height for camera placement.

Preliminary Tests

The researchers, along with assistants, conducted preliminary tests on Friday, September 3, 2022. Equivalence testing was performed for the research sample individuals, as illustrated in Table (2).

Proposed Special Exercises

After conducting the filming and preliminary tests, the researchers analyzed the results and developed specific exercises suitable for the research sample. These exercises were presented to a group of experts in the field of biomechanics and table tennis coaching for evaluation and feedback. The exercises were implemented over a period of 8 weeks, with (3) training sessions per week.

Main Experiment

The special exercises were implemented in the training program for the research sample participants starting from Monday, October 17, 2022, until December 9, 2022. The training sessions lasted for 20 minutes during the preparatory phase, and the exercises were executed at intensities ranging from 60% to 100%, with a workload

ratio of (1:2) across the week. Consideration was given to the repetitions and rest periods between exercises based on their difficulty. See Appendix (1).

Post-Test

The post-tests were conducted on Monday, December 12, 2022, under the same conditions as the preliminary tests.

Statistical Analysis

The researchers used the SPSS statistical package for data analysis.
Experts: S. Tomas , C. Emanuel , B . Christina

CHAPTER THREE

Presentation and Discussion of Results

After collecting and statistically processing the data using the paired sample t-test to assess differences between the control and experimental groups in pre-test and post-test measurements, as well as differences in post-tests between the experimental and control groups, the researchers presented and discussed the results to evaluate the achievement of the research objectives and hypotheses.

From Table (3), significant differences were found between the pre-test and post-test measurements for the experimental group in both the distinctive speed of arm strength and the speed and accuracy of the forehand topspin stroke at a significance level of (0.05). As for the control group, Table (4) indicates significant differences between pre-test and post-test measurements in the variables of accuracy and speed, with no significant differences observed in the distinctive speed of arm strength. Furthermore, Table (5) shows significant differences in the post-tests between the experimental and control groups, favoring the experimental group in all variables under investigation.

Table (3) shows the arithmetic means, standard deviations, and the computed (t) values between pre-test and post-test measures for the experimental group.

Statistical Treatment Variables	Measurement unit	Pre-test		Post-test		Factorial Significance	Factorial Interaction	T value	sig
		x	y	x	y				
the distinctive speed force Shnaou 10 seconds	Number	6.83	0.753	12.33	1.751	-0.50	0.778	7.060	0.000
Ball speed	m/s	9.5	1.045	12.00	0.632	-2.50	0.500	5.00	0.001
Ball Accuracy	Degree	9.33	0.816	16	1.414	-6.667	0.667	10.00	0.000

The t-value is statistically significant at ≤ (0.05)

Table (4) shows the arithmetic means, standard deviations, and the computed (t)-value between the pre-test and post-test for the control group.

Statistical Treatment Variables	Measurement unit	Pre-test		Post-test		Factorial Significance	Factorial Interaction	T value	sig
		x	y	x	y				
the distinctive speed force Shnaou 10 seconds	Number	7.5	0.548	8.17	0.753	-0.66	0.38	1.754	0.110
Ball speed	m/s	9	1.095	10.17	0.75	-1.167	0.543	2.15	0.055
Ball Accuracy	Degree	9.17	0.753	13.50	1.87	-4.33	0.823	5.26	0.000

Table (5) displays the arithmetic means, standard deviations, and the computed (t)-value between the post-tests for both the control and experimental groups.

Statistical Treatment Variables	Measurement unit	Control Group		Experimental Group		Factorial Significance	Factorial Interaction	T value	sig
		x	y	x	y				
the distinctive speed force Shnaou 10 seconds	**Number**	**12.33**	**1.751**	**8.17**	**0.753**	**4.167**	**0.778**	**5.354**	**0.000**
Ball speed	**m/s**	**12.00**	**0.632**	**10.17**	**0.75**	**1.833**	**0.401**	**4.568**	**0.001**
Ball Accuracy	**Degree**	**16**	**1.414**	**13.50**	**1.87**	**-2.5**	**0.957**	**2.611**	**0.026**

Through Table (3), significant differences are observed between the pre-tests and post-tests for the experimental group in the variable of arm speed specialization, as well as in the speed and accuracy of the ball test, favoring the post-tests. From Table (4), significant differences are evident between the pre-tests and post-tests for the control group in ball speed and accuracy, favoring the post-tests. No significant differences were found for the variable of arm speed specialization. Table (5) indicates statistically significant differences between the experimental and control groups in the post-tests across all mentioned variables, favoring the experimental group.

DISCUSSION OF RESULTS

From the above results, it is evident that the experimental group outperformed the control group in all variables, despite the improvements observed in the control group due to significant differences between the pre-tests and post-tests in the variable of ball speed and accuracy. Researchers attribute this superiority to the effectiveness of the exercises used during the training period, which focused on various variables including arm strength. Through these exercises, specific techniques were implemented along with modern training methods, which are considered crucial factors stimulating the player's ability and creativity in understanding the relationship between distance from and proximity to the table. Additionally, understanding the angle of the arm used at the moment of hitting the ball, and neuromuscular coordination play essential roles in adapting and quickly adjusting to the technical performance of movements at a high skill level.

This is what Simpson (1990) pointed out, indicating that one of the most important physical abilities required for players is speed-strength and accuracy during performance, which distinguishes table tennis from other sports.

Some researchers also emphasize that arm strength has a significant and effective impact on determining the accuracy of stroke performance (Hameed, Abdalkarim, 2022).

Furthermore, some researchers affirm that muscle flexibility is a crucial factor in most gymnastic movements. Therefore, muscular coordination around the body joints enhances joint range of motion, which reflects on movement speed and agility (Jary, et al., 2019).

This aligns with findings from Al-Azzawi Faisal, et al. (2019), who assert that focusing on arm strength is an important and influential factor in stroke accuracy.

Some researchers suggest that in order to achieve accuracy in ball placement, the player should not exceed the required range of motion, particularly in the angle of the striking arm, ensuring the shortest possible time to reach the intended area (Abdul Razzaq, et al., 2019).

Researchers also argue that the close-to-table topspin stroke is characterized by power and speed, necessitating the player to reduce the angle of their arm to control and accurately direct the ball to a specific location on the opponent's table for scoring points.

Schmidt and Craig (2000) agree, emphasizing that playing close to the table enhances player accuracy in executing and directing strokes, reducing the likelihood of dispersion.

Additionally, Ali (2009) adds that such strokes feature a low trajectory and are employed by players as surprise attacks against incoming close or distant topspin shots from the opponent, causing significant confusion and potentially scoring points.

Based on these perspectives, researchers observe that players move strategically between different positions, whether near or far from the table, depending on the type of play and the opponent's shots. Therefore, it is crucial for players to effectively utilize their position at the table, enabling them to execute strokes with an appropriate arm angle to maintain high control, especially when close to the table. Moving away from the table may affect the player's ability to accurately predict ball placement, giving the opponent ample time to strategize and counter effectively.

This aligns with Simpson's assertion that the type of stroke executed by the player and their position relative to the table, whether close or distant, significantly determine the angle of the playing arm (Ali, et al., 2019).

Furthermore, Salah Hadi and Kadhum Abdul (2022) indicate that possessing a high level of diverse motor abilities enables individuals to successfully perform a variety of movements.

Schmidt (2000) adds that the success of movement dynamics, such as transferring force between body parts, starting from the legs as the initial part of the movement and ending with the arm, requires executing movements in a smooth, interconnected series to produce the required force.

Salah Hadi and Kadhum Abdul (2023) also indicate that correct execution of motor pathways or motor tasks acts as a stimulus for performance success, as accuracy results from the interaction of interconnected mechanical variables.

Researchers (Shakir Hammood, et al., 2021) affirm that understanding the biomechanical variables of players can lead us to achieve the correct pathway for skill execution by understanding the precise relationship of each variable in performance, thereby enabling optimal performance.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The specific exercises using ropes had a positive impact on developing the researched variables for the experimental group.
2. There was improvement in the variable of speed and accuracy of the forehand stroke for the control group of the research.
3. The control group did not show improvement in the variable of speed-specific strength for the arms.
4. The improvement in the researched variables favored the experimental group, confirming the effectiveness of the exercises employed by the researchers.

Recommendations

1. Emphasize the use of specific exercises that enhance physical capabilities directly influencing stroke performance in table tennis.
2. Conduct studies to explore the development of players' ability to utilize physical and biomechanical capabilities for other skills in table tennis.

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