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The Effect of Tabata Training on Muscular Strength and Agility in Taekwondo Keorugi Players

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Abstract

This study aimed to investigate the impact of Tabata training on muscular strength and agility among Kyorugi-specialized female Taekwondo players. The sample was purposively selected from female Taekwondo players registered with the Egyptian Taekwondo Federation for the 2022-2023 sports season. The participants were aged 12-14 years and totaled 26 players, divided as follows:

- **Experimental group:** 8 players
- **Control group:** 8 players
- **Scientific validation and exploratory study group:** 10 players

The study was conducted at the International Taekwondo Center in Maadi. The researcher employed the experimental method due to its suitability for the study's nature, utilizing a pre- and post-test design for both the experimental and control groups.

The main findings revealed that the proposed training program incorporating Tabata exercises positively influenced the development of muscular strength and agility in the experimental group of Kyorugi players. The inclusion of Tabata training in the experimental group's regimen led to notable improvements in both variables.

Recommendations:

1. Incorporate Tabata training into training programs, particularly during the preparatory phase for competitions.
2. Conduct further similar studies to enhance physical fitness components for Taekwondo players across various age groups.

ملخص البحث:

هدفت هذه الدراسة إلى التعرف على تأثير تدريبات التاباتا على القوة العضلية والرشاقة لدى لاعبات التايكوندو المتخصصات في القتال (كيروجي). تم اختيار عينة البحث بشكل عمدي من لاعبات التايكوندو المسجلات في الاتحاد المصري للتايكوندو خلال الموسم الرياضي ٢٠٢٢-٢٠٢٣، وتراوحت أعمار المشاركات بين ١٢ و١٤ سنة. بلغ إجمالي العينة ٢٦ لاعبة، وتم تقسيمهن إلى ثلاث مجموعات:

- **المجموعة التجريبية** 8 :لاعبات
- **المجموعة الضابطة** 8 :لاعبات
- **مجموعة الدراسة الاستطلاعية (لحساب المعاملات العلمية)** 10 :لاعبات

تم إجراء الدراسة في نادي إنترناشيونال تايكوندو سنتر بالمعادي. استخدمت الباحثة المنهج التجريبي لملاءمته لطبيعة الدراسة، حيث تم تطبيق التصميم التجريبي بإجراء القياسات القبلية والبعدية لكل من المجموعتين التجريبية والضابطة.

أهم النتائج

- أظهر البرنامج التدريبي المقترح، الذي تضمن تدريبات التاباتا، تأثيرًا إيجابيًا على تنمية كل من القوة العضلية والرشاقة لدى المجموعة التجريبية.
- أدى دمج تدريبات التاباتا في البرنامج التدريبي إلى تحسينات ملحوظة في مكونات اللياقة البدنية قيد الدراسة لدى المجموعة التجريبية.

التوصيات

١. دمج تدريبات التاباتا ضمن البرامج التدريبية، خاصة خلال فترة الإعداد للمنافسات، لتحسين الأداء في قتال التايكوندو (كيروجي).

٢. إجراء مزيد من الدراسات لاستكشاف تطوير عناصر اللياقة البدنية في التايكوندو بمراحل عمرية ومستويات مهارية مختلفة.

The Effect of Tabata Training on Muscular Power and Agility in Taekwondo Kyorugi Players

Introduction and Research Problem:

Many coaches believe that sports training is more of an art than a science, relying on the coach's creative and artistic abilities to interpret and address athletes' challenges. While this belief is valid to some extent, creativity in training lacks depth and significance unless it is grounded in scientific principles that maximize the athlete's potential. Thus, the combination of scientific foundations with creative approaches defines the successful coach. (17) (32)

Tabata is a relatively recent addition to the training landscape, introduced in the 1990s by Dr. Izumi Tabata. (31)

Tabata training it is a high-intensity interval training (HIIT) method that alternates short periods of intense effort with brief rest intervals. This method is considered highly demanding as the work phases require maximum effort while the rest periods are minimal. (23) (34)

Dr. Tabata and his team conducted research on two groups of athletes: one trained at moderate intensity, and the other at high intensity. The findings demonstrated that high-intensity interval training had a greater impact on both aerobic and anaerobic systems. (25) (33)

The researcher notes that, based on the modern playing style and the study's subject, **muscular power** is of great importance in Taekwondo. Athletes need this power for performing various kicks during both attacks and counterattacks, as well as for executing jumping kicks that demand strong leg muscles. **Agility**, on the other hand, is a critical component in most physical activities, especially Taekwondo. It is crucial for quick muscle contractions in single movements, executing kicks and complex skills sequentially in the shortest time possible, and selecting the optimal timing for skill execution.

Agility is also essential for Taekwondo athletes as many offensive and defensive techniques involve full-body rotation mid-air. This requires the athlete to leave the ground, rotate, and perform the skill, which demands excellent coordination and the ability to quickly adjust to changing situations.

Taekwondo is a modern combat sport included in the Olympic Games since 2000. (21) (22) (29)

The term *Taekwondo* is a Korean word comprising three parts:

- **Tae:** meaning "foot" or "kick."
- **Kwon:** meaning "fist."
- **Do:** meaning "way" or "method."

The sport's emphasis on the use of legs and feet distinguishes it from other martial arts. (30)

Recent amendments to international Taekwondo regulations, including scoring methods and round determination, along with the requirement for athletes to participate in multiple matches in a single day, have increased the physical demands on players. This intensifies the need to improve muscular power and agility, as deficiencies in these areas may affect performance during matches.

The researcher believes that integrating Tabata training into a program can significantly enhance both aerobic and anaerobic fitness levels. This, in turn, can help coaches design programs that improve muscular power and agility in Taekwondo athletes. Such programs would enable athletes to endure match pressures, effectively counter opponent kicks, and elevate their physical capabilities to achieve optimal results.

This motivated the researcher to conduct the current study, which investigates "The Effect of Tabata Training on Muscular Power and Agility in Taekwondo Kyorugi Players."

Research Importance:

1. **Academic Importance:** This study contributes new scientific insights to the field of Taekwondo Kyorugi training.
2. **Practical Importance:** The findings can help coaches improve muscular power and agility using Tabata training, thus elevating physical performance in Taekwondo.

Research Objectives:

The study aims to design a training program utilizing Tabata exercises to investigate their effects on: Muscular power, Agility.

Research Hypotheses:

1. There are statistically significant differences in muscular power and agility between pre- and post-tests for the experimental and control groups, favoring the post-test results.
2. There are statistically significant differences in post-test results between the experimental and control groups, favoring the experimental group.

3. There are improvement rates in muscular power and agility between pre- and post-tests for both groups, favoring the experimental group.

Scientific Terminology:

1. **Tabata Training:**

"A high-intensity interval training method involving short work periods followed by very brief rest intervals". (23) (34)

2. **Taekwondo:**

"A Korean martial art that combines kicks and punches, where the word is composed of:

- **Tae:** Foot
- **Kwon:** Fist
- **Do:** Way". (8: 12, 13)

3. **Kyorugi (Sparring):**

"A combat style in Taekwondo involving direct competition between two athletes. Players wear protective gear and aim to score points by delivering legal kicks to the torso and head as per international Taekwondo rules". (1: 28)

4. **Physical Variables:**

"Elements of physical fitness that enhance the specific performance capabilities required in Taekwondo." (Operational Definition)

Table (1)
Previous and Related Studies (Arabic and Foreign)

Researcher Name	Year	Research Type	Research Title	Research Objective	Research Methodology	Research Sample	Research Results	Reference No.
1-Mohamed Magdy Amara	2015	PhD Research	The Effect of Hypoxic Training on Anaerobic Capacity of Taekwondo Players	Designing a set of hypoxic training exercises to influence anaerobic capacity and some physical abilities.	Experimental	(12) players under 14 years old	Hypoxic training strongly influences anaerobic capacity and some physical abilities.	13
2-Maher Ahmed Al-Eisawi, Abdel Ghafar Jabari	2017	Published research	Using Modern Training Methods to Develop Physical and Motor Abilities of Taekwondo Players	Investigating the impact of a training program using modern methods to develop some physical and motor abilities of taekwondo players.	Experimental	(22) players aged 12–14 years	Modern training methods enhanced the effectiveness of the exercises in the training program.	10
3-Fatma Salah Gomaa	2020	Published research	The Effect of CrossFit Training on Motor Fitness and the Performance of the Skill (360° Rotational Front Kick) for Taekwondo Players	The effect of CrossFit training on motor fitness components, skill performance level, and improvement ratios of taekwondo players.	Experimental	(35) players aged 18–21 years	CrossFit training improves motor fitness and physical abilities of taekwondo players.	7

4-Mohamed Elsayed Mohamed Abdel-Galil	2020	Published research	The Effect of Combined Training on Some Physical Abilities and Footwork Movements in Kyorugi Taekwondo	The impact of the proposed program on speed-strength, leg strength endurance, agility, and footwork movements for kyorugi taekwondo players.	Experimental	(18) players	The proposed training program improves speed-strength, strength endurance, agility, and footwork movements in kyorugi players.	11
5-Fahmy Fachrezzy, Uzizatun Masliah, Iwan Hermawan	2024	Published research	Physical Training Methods to Improve Physical Fitness Components for Elite Kyorugi Taekwondo Players: A Systematic Review	Providing a systematic review of physical training methods to enhance fitness components for elite kyorugi taekwondo players.	Descriptive		Various training techniques effectively enhance the physical attributes of elite kyorugi taekwondo players, including flexibility, responsiveness, power, coordination, agility, speed, balance, and VO2max.	24

Based on the research and review of scientific references and previous studies, it was not evident within the researcher's knowledge that a Tabata training program has been applied to improve fitness performance in taekwondo.

Research Plan and Procedures:

Research Methodology:

The researcher utilized the **experimental method** due to its suitability for the type and nature of the research. The experimental design involved two groups: an experimental group and a control group, with pre- and post-measurements applied to both groups.

Research Population:

The research population consisted of **female taekwondo players** specializing in the "Kyorugi competition" at the **International Taekwondo Center** in Maadi. These players were registered with the Egyptian Taekwondo Federation for the **2022–2023 sports season**, aged between **12 and 14 years**.

Research Sample:

The sample was deliberately selected from female taekwondo players specializing in Kyorugi and registered with the Egyptian Taekwondo Federation for the **2022–2023 sports season**, aged between **12 and 14 years**. The sample included:

- **8 players** for the experimental group.
- **8 players** for the control group.
- **10 players** for calculating scientific constants and standardizing the tests used in the research and conducting the pilot study.

Reasons for Selecting the Sample:

1. All sample members were registered with the Egyptian Taekwondo Federation for the **2022–2023 sports season** in Kyorugi.
2. The age range of the sample was suitable for the training program.
3. The players were motivated to achieve sports success in taekwondo.
4. The players showed commitment to training throughout the sports season.
5. The sample members adhered to the training program.
6. Regular attendance at scheduled training sessions was ensured.
7. Participation in two seasons of national and international championships.

Homogeneity of the Research Sample:

The researcher calculated the **skewness coefficient** based on the arithmetic mean and standard deviation for the research sample in growth variables (age, height, weight, and years of training experience), as shown in **Table (2)**.

Table (2)
Statistical Description of the Experimental, Control, and Pilot Samples in Age, Height, Weight, and Training Age Variables *(N = 26)*

No.	Variables	Unit of Measurement	Mean	Standard Deviation	Median	Skewness Coefficient
1	Age	Years	13.000	0.894	13.000	0.000
2	Height	cm	149.923	3.071	150.000	-0.370
3	Weight	kg	42.423	3.372	42.000	0.531
4	Training Age	Years	6.307	0.470	6.000	0.885

It is evident from **Table (2)** that the skewness coefficient for growth rates and years of experience in the total research sample ranges between (**-0.370 and 0.885)**, which is within the acceptable range of **(±3)**. This indicates normality of the data and homogeneity of the research sample.

The researcher also calculated the skewness coefficient based on the arithmetic mean and standard deviation for the research sample in the tests under investigation, as shown in **Table (3)**.

Table (3)
Statistical Description of the Experimental, Control, and Pilot Samples in Physical Variables *(N = 26)*

Variables	Unit of Measurement	Mean	Standard Deviation	Median	Skewness Coefficient
Muscular Power	cm	153.115	3.374	153.000	-0.453
Agility	sec	13.158	0.0649	13.1550	1.153

From **Table (3)**, it is clear that the skewness coefficients for the physical variables under investigation in the main research sample range between (**-0.453 and 1.153)**, which is within the acceptable range of **(±3)**. This indicates normality of the data and homogeneity in the physical variables.

-Equivalence:

Table (4)
Significance of Differences Between the Experimental and Control Groups in Pre-Measurements for Variables (Age, Height, Weight, and Training Age) Using the Mann–Whitney Test *(N = 16)*

Variables	Groups	Mean Ranks	Sum of Ranks	U	Z	P Error Probability
Age	Experimental (N=8)	7.81	62.50	26.500	0.657	0.511
	Control (N=8)	9.19	73.50			
Height	Experimental (N=8)	7.50	60.00	24.000	0.850	0.395
	Control (N=8)	9.50	76.00			
Weight	Experimental (N=8)	7.69	61.50	25.500	0.688	0.492
	Control (N=8)	9.31	74.50			
Training Age	Experimental (N=8)	7.50	60.00	24.000	1.000	0.317
	Control (N=8)	9.50	76.00			

From **Table (4)**, the Z-values are statistically non-significant across all variables (Age, Height, Weight, and Training Age) in pre-measurements. This indicates **equivalence** between the two groups in these variables.

Table (5)
Significance of Differences Between the Experimental and Control Groups in Pre-Measurements for Physical Variables Using the Mann–Whitney Test *(N = 16)*

Variables	Groups	Mean Ranks	Sum of Ranks	U	Z	P Error Probability
Muscular Power	Experimental (N=8)	8.50	68.00	32.000	0.000	1.000
	Control (N=8)	8.50	68.00			
Agility	Experimental (N=8)	6.94	55.50	19.500	1.321	0.187
	Control (N=8)	10.06	80.50			

From **Table (5)**, the Z-values for the physical variables (Muscular Power and Agility) are statistically non-significant in pre-measurements. This confirms **equivalence** between the two groups in these variables as well.

-Time Frame:

Research Period:

- All measurements and training under study were conducted during the sports season (2022–2023).
- The exploratory study was conducted from **May 5, 2024, to May 14, 2024**.
- Pre-measurements were conducted from **May 14, 2024, to May 16, 2024**.
- The main training study was implemented from **Sunday, May 19, 2024, to Thursday, August 15, 2024**, spanning 12 weeks (3 months) with **3 sessions per week**, totaling **36 training units**.
- Post-measurements were conducted from **August 18, 2024, to August 20, 2024**.

Data Collection Tools:

Different tools were used to suit the research's nature and objectives. The researcher utilized the following:

Devices and Equipment:

- **Medical Scale** for measuring weight in kilograms.
- **Restameter** for measuring body height in centimeters.
- Stopwatch, camera, small rope, measuring tape.
- Sandbags, mat, headguard, shin/arm protectors, chest protector (hogu).
- Taekwondo uniform, training hall.
- Player result recording forms.

- **Questionnaires: (Annex 2)**

The researcher designed two questionnaires:

1. **Expert Opinion Form** to determine the physical tests under study.
2. **Expert Opinion Form** to define the content of the training program (duration, time, content).

Table (6)
Expert Opinions on Physical Tests Under Study *(N=11)*

No.	Category	Test	Count	Percentage
1	Muscular Power	Standing Broad Jump	11	100%
		Standing Vertical Jump	0	0%
		Repeated Jumps in Place	0	0%
2	Agility	Multi-directional Run	8	73%
		Zigzag Run (Barrow Test)	0	0%
		Multi-dimensional Shuttle Run	3	27%

From **Table (6)**, expert opinion percentages on physical tests ranged from (**73% to 100%**). Tests with an approval rate of (**73%) or higher** were selected as follows:

- **Physical Tests:** Annex (3)
- **Muscular Power Test:** Standing Broad Jump. *(2:36)*
- **Agility Test:** Multi-directional Run. *(12:279–280)*

Table (7)
Expert Opinions on Training Program Elements *(N=11)*

No.	Element	Program Content	Count	Percentage
1	Program Duration (Weeks)	8 weeks	2	18%
		10 weeks	3	27%
		12 weeks	6	55%
2	Weekly Training Sessions	3 sessions	9	82%
		4 sessions	1	9%
		5 sessions	1	9%
3	Training Unit Duration	45 minutes	1	9%
		60 minutes	0	0%
		90 minutes	9	82%
		120 minutes	1	9%
4	Training Load Ratio	1:1	1	9%
		1:2	9	82%
		1:3	1	9%

From **Table (7)**, based on a **55% or higher approval rate**, the following training program elements were defined:

- **Duration:** 3 months (12 weeks).
- **Weekly Sessions:** 3 sessions per week, totaling 36 sessions.
- **Session Duration:** 90 minutes.
- **Training Load Ratio:** 1:2.

Scientific Validity and Reliability of the Tests Used:

First: Validity of the Tests (Differentiation Validity):

The researcher applied the selected tests to an exploratory sample outside the main research sample but from the same population. Differentiation validity was assessed using the **"distinctive group"** and **"non-distinctive group"** method on **10 players** during the period **May 5–7, 2024**. The results are shown in **Table (8)**:

Table (8)
Differences Between Distinctive and Non-Distinctive Groups
(Using Mann–Whitney Test, N=10)

Variable	Groups	Rank Mean	Rank Sum	U	Z	P (Error Probability)
Muscular Power	Distinctive	3.00	15.00	0.00	2.611	0.009
	Non-Distinctive	8.00	40.00			
Agility	Distinctive	8.00	40.00	0.00	2.611	0.009
	Non-Distinctive	3.00	15.00			

From **Table (8),** The **Z-values** were statistically significant for all physical variables, favoring the distinctive group. This indicates that the physical tests (muscular power and agility) possess an acceptable degree of **validity**.

Second: Reliability of the Tests (Test-Retest Method)

The researcher assessed the reliability of the tests using the **test-retest method** with a one-week interval between applications on the exploratory sample (10 players). The tests were conducted from **May 5–7, 2024**, and repeated under the same conditions from **May 12–14, 2024**, using identical tools. Correlation coefficients were calculated between the results of the two applications, as shown in **Table (9):**

Table (9)
Correlation Coefficients Between Test and Retest Results
(Physical Tests, N=10)

Variable	Test 1		Test 2		r-value
	(S)	SD (σ)	(S)	SD (σ)	
Muscular Power	154.0000	2.66667	154.1000	2.76687	0.994
Agility	13.1920	0.08149	13.1800	0.05497	0.913

The **critical r-value at 0.05 significance level = 0.643**.

It is evident from Table (9) that the correlation coefficients between the first and second applications of the muscular strength and agility tests ranged from (0.913 to 0.994), indicating that the muscular strength and agility tests have an acceptable level of reliability.

Training Program:

1. Objective of the Program:

The proposed training program aims to determine the impact of Tabata training on muscular power and agility for female Kyorugi competitors. The researcher designed the program with a focus on balancing and varying the exercises to develop these physical attributes. This was done in alignment with the prioritization and proportional requirements of physical fitness components essential for Taekwondo performance. Through an extensive review of scientific literature, previous studies, and online resources, the researcher compiled and designed a set of Tabata exercises. Expert opinions on these exercises were collected through a structured survey. (Annex 1, 2)

2. Fundamental Considerations for Exercise Selection in the Program:

- Ensure the exercises are age-appropriate for the participants.
- Take into account individual differences among players.
- Align exercises with the overall training objectives.
- Carefully adjust and control the intensity of training loads.
- Maintain appropriate ratios between work and rest periods during training.
- Implement gradual progression in the intensity and complexity of exercises.
- Select exercises that mimic the skills being studied in the research.

- Emphasize safety and security in all exercises to prevent injuries.
- Incorporate engaging and stimulating exercises to enhance motivation.
- Ensure exercises are simple and match the players' current fitness and skill levels. (Annex 5, 6)

3. Determining the Content of the Program:

The researcher relied on previous studies and research on Taekwondo training programs, as well as the opinions of 11 Taekwondo experts (Annex 1). The program's content was designed to align with the research objective: improving the muscular power and agility of female Kyorugi competitors and examining its impact on their performance in championships, particularly their ability to finish matches efficiently. (Annex 6, 7)

Table (10)
Expert Opinions on the Proposed Program Content and Percentages (N=11)

No.	Components	Number of Agreements	Percentage
1	Warm-up (free running, rope exercises, stretching)	9	82%
2	Main section (special physical preparation exercises)	9	82%
3	Main section (technical preparation exercises)	9	82%
4	Main section (match preparation exercises)	9	82%
5	Cool-down	6	55%

The percentages from Table (10) indicate strong agreement among experts regarding the content of the program, with (82%) for warm-up, special physical preparation, technical preparation, and match preparation exercises. The cool-down section received a lower agreement of (55%).

The proposed exercises under investigation (Annex 6) are categorized as follows (Warm-Up Exercises (Free running- Rope exercises- Stretching), Main Section Exercises (Special Physical Preparation (Muscular power exercises- Movement speed exercises- Agility exercises- Speed endurance exercises- Performance endurance exercises- Flexibility exercises), Technical Preparation (Muscular power exercises- Movement speed exercises- Agility exercises- Speed endurance exercises- Performance endurance exercises) Match Preparation Exercises, Cool-Down Exercises) These exercises were carefully designed to achieve the research objectives and cater to the physical and technical needs of Kyorugi competitors.

Proposed Exercises for the Study (280 exercises), distributed as follows:

1. Warm-Up Exercises (110) exercises (Free running exercises: 60 exercises, Rope exercises: 15 exercises, Stretching exercises: 35 exercises).
2. Main Section Exercises (140) exercises:

- Special Physical Preparation (50) exercises (Muscular power exercises: 8 exercises, Movement speed exercises: 8 exercises, Agility exercises: 8 exercises, Speed endurance exercises: 8 exercises, Performance endurance exercises: 10 exercises, Flexibility exercises: 8 exercises.
- Technical Preparation (41) exercises (Muscular power exercises: 8 exercises, Movement speed exercises: 8 exercises, Agility exercises: 8 exercises, Speed endurance exercises: 9 exercises, Performance endurance exercises: 8 exercises).
- Match Preparation Exercises: 49 exercises.

3. Cool-Down Exercises (30 exercises). (Annex 6)

4- Time Division and Program Duration:

The researcher designed a three-month training program (12 weeks) consisting of three training sessions per week, totaling 36 training sessions. The duration of each session ranged between 78 to 117 minutes, depending on the intensity of the workload. Table (7) presents expert opinions on the distribution of the training program components.

- **Week 1:** Session duration ranged from 78 to 82 minutes.
- **Week 2:** Session duration ranged from 84 to 88 minutes.
- **Week 3:** Session duration ranged from 88 to 90 minutes.
- **Week 4:** Session duration ranged from 84 to 88 minutes.
- **Week 5:** Session duration ranged from 80 to 88 minutes.
- **Week 6:** Session duration ranged from 88 to 96 minutes.
- **Week 7:** Session duration ranged from 86 to 90 minutes.
- **Week 8:** Session duration ranged from 84 to 90 minutes.
- **Week 9:** Session duration ranged from 93 to 103 minutes.
- **Week 10:** Session duration ranged from 91 to 96 minutes.
- **Week 11:** Session duration ranged from 84 to 90 minutes.
- **Week 12:** Session duration ranged from 104 to 115 minutes. (Annex 7)

5- Program Implementation:

The researcher designed a training program and divided each training session into the following sections:

1. **Warm-up and Stretching:** The duration ranged from (17 to 20) minutes, comprising (110) exercises, including various types of running exercises aimed at improving endurance, speed, and agility, as well as rope exercises and stretching. The intensity gradually increased from (40%) in the first session to (50%) by the 36th session.
2. **Special Physical Preparation:** The duration ranged from (20 to 25) minutes, with (50) exercises targeting the development of muscular strength, speed, agility, speed endurance, performance endurance, and flexibility. The intensity progressed from (60%) to (94%).
3. **Skill Preparation:** The duration ranged from (18 to 35) minutes, including (41) exercises of varying difficulty, with the intensity ranging between (61%) and (95%).
4. **Competitive Preparation:** The duration ranged from (14 to 35) minutes, including (49) exercises, with increasing difficulty based on training load and intensity, ranging from (62%) to (97%).
5. **Cool-down Section:** The duration ranged from (3 to 5) minutes, including (30) exercises designed to aid recovery and relaxation of the working muscles after high-intensity training and effort.

The researcher designed the training load with increasing difficulty according to the principle of progression. This is because if the training load is increased too quickly, there is a risk of overtraining, and the body may become unable to adapt, potentially leading to physical and mental breakdown. In accordance with the principle of variation, the program includes a balance between work and rest, and hard versus easy exercises. Continuous training sessions without adequate rest and recovery periods will undoubtedly hinder progress in training and the players' physical and skill capacities. Following the principle of interval training and Tabata training, the intensity of the exercises will gradually increase, decrease slightly, and then increase again. (Annex 5)

The researcher used the Tabata method of high-intensity interval training (HIIT) for its significant benefits in improving aerobic and

anaerobic capacity, increasing endurance, and enhancing strength, which is more effective than regular one-hour sessions. The work-to-rest ratio was (2:1), meaning after performing a set for 20 seconds, a 10-second rest period follows. This work-to-rest pattern involves half the time spent resting compared to the time spent exercising. (Annex 5)

Table (11) provides a model of a training session from the proposed training program with the numbers of exercises: (Annex 7)

Table (11)
Model for a Training Session from the Proposed Training Program

- **Week 1:** Unit Number (1) - **Time:** 78 minutes
- **Day:** Sunday - **Date:** 19/5/2024
- **Physical Goal:** Developing muscular power and movement speed
- **Skill Goal:** Developing muscular power and movement speed through selected kicks under investigation

Component	Performance Time	Training Intensity	Exercise Time	Energy System	Number of Sets	Rest Interval	Performance Form	Execution Content of Training Session Components
Warm-up & Stretching	10 minutes	40%	20 seconds	Anaerobic	2	-	Rows	(1-22) (76-110)
Special Physical Preparation	20 minutes	60%	20 seconds	Anaerobic	8	10 seconds	Paired	(111, 112) (119, 120)
Skill Preparation	20 minutes	61%	20 seconds	Anaerobic	8	10 seconds	Paired	(161, 164) (169, 172)
Combat Preparation	14 minutes	62%	35 seconds	Anaerobic	4	15 seconds	Paired	(202-205)
Cool-down	4 minutes	30%	30 seconds	Aerobic	2	-	Rows	(251-256, 261-264, 271-275)

This table outlines the components of the proposed training unit, including the time, intensity, energy system, and execution details for each segment of the training session.

- The Exploratory Study:

- First Exploratory Study:

This study was conducted from 5-7/5/2024 with an exploratory sample consisting of 10 female taekwondo athletes from the research population, outside the main sample.

The exploratory study aimed to ensure the following:

1. The validity and appropriateness of the tests for the research sample.
2. The validity of the tools and equipment used.
3. The athletes' ability to perform the tests.
4. The application of some units from the proposed training program on the athletes.
5. Determining the number of sets and exercises used within the proposed program and the time allocated for each part of the session.
6. Training the assistants on the measurement and recording methods.
7. The validity of the recording forms.

The results of this study showed:

1. Identification of difficulties that may be encountered when performing the measurements and tests.
2. The validity of the tools and equipment used.
3. The athletes' ability to perform the tests.
4. The appropriateness of the training program's units for the athletes' level.
5. The suitability of the number of sets in the training session.
6. The assistants' understanding of the measurement process, ensuring consistency in conducting the same tests across the sample.
7. The validity of the recording forms.
8. Determining the appropriate arrangements for conducting the tests under investigation.

- Second Exploratory Study:

This study took place from 5-7/5/2024 with the purpose of calculating the scientific coefficients (validity). The tests were re-administered on the exploratory sample from 12-14/5/2024, one week after the initial test, to calculate the scientific coefficients (reliability). The sample consisted of 10 female taekwondo athletes from the research population, outside the main sample.

- The Main Study:

- Pre-Test Measurement:

The researcher conducted the pre-test measurement for both the experimental and control groups during the period of 14-16/5/2024. This was done according to the specifications and performance conditions of each test, with uniform measurements, testers, and timing after conducting the exploratory study.

- Implementation of the Program:

The researcher applied the training program to the experimental sample over a period of three months, from Sunday, 19/5/2024, to Thursday, 15/8/2024. The program included three training units per week on Sunday, Tuesday, and Thursday, with each training unit lasting between 78 and 117 minutes, for a total of 36 training units.

- Post-Test Measurement:

After completing the training program as scheduled, the researcher conducted the post-test measurement for the experimental sample, following the same conditions and specifications as the pre-test, to ensure the accuracy and reliability of the data. This measurement took place between 18-20/8/2024, and the data was entered into prepared tables for statistical processing. (Annex 4)

- Statistical Processing:

After collecting and recording the various measurements of the variables used in the research, the appropriate statistical treatments were applied to achieve the objectives and verify the hypotheses using statistical formulas and computer software ("SPSS"). The following statistical methods were used:

1. Descriptive statistics. 2. Spearman correlation coefficient.
3. Mann-Whitney test for differences. 4.One-way analysis of variance (ANOVA).
5. Least Significant Difference (LSD) test. 6. Improvement percentages.
7. Mean. 8. Standard deviation. 9. Median.

- Presentation and Interpretation of Results:

Table (12)

Significance of differences between pre-test and post-test measurements for the experimental group in some physical variables under investigation (N=8)

Variables	Pre-Test (Mean)		Post-Test (Mean)		Rank Sum	Average Rank	Sign Direction	Z Value	Error Probability
	(S)	SD (σ)	(S)	SD (σ)					
Muscular Power	152.3750	4.37321	172.7500	8.69729	0.00 36.00	0.00 4.50	-0 +8 =0	2.521	0.012
Agility	13.1225	0.5175	12.7550	0.6568	36.00 0.00	4.50 0.00	-8 +0 =0	2.536	0.011

From **Table (12)**, it is clear that the calculated **Z value** was statistically significant between the pre-test and post-test measurements for the experimental group on some of the physical variables under investigation, with post-test measurements showing superior results.

Table (13)

Improvement Rates Between Pre-Test and Post-Test Averages for the Experimental Group in Some Physical Variables (N=8)

Variables	Pre-Test Average	Post-Test Average	Improvement Rate (%)
Muscular Power	152.3750	172.7500	13.4
Agility	13.1225	12.7550	2.9

From **Table (13)**, it is evident that the improvement rates between pre-test and post-test measurements for the experimental group in the physical variables under investigation ranged between (**2.9%** and **13.4%)**.

Table (14)

Significance of Differences Between Pre-Test and Post-Test Measurements for the Control Group in Some Physical Variables Under Investigation (N=8)

Variables	Pre-Test		Post-Test		Sum of Ranks	Mean Ranks	Sign Direction	Z Value	Significance (p)
	(M)	SD	(M)	SD					
Muscular Power	152.7500	3.24037	153.7500	3.24037	0.00 36.00	0.00 4.50	-0 +8 =0	2.828	0.005
Agility	13.1538	0. 2722	13.1525	0. 2493	19.00 17.00	3.80 5.67	-5 +3 =0	0.144	0.885

From **Table (14)**, **Muscular Power:** The computed **Z-value (2.828)** is statistically significant (**p = 0.005**) in favor of the post-test measurements, indicating improvement in muscular power for the control group, **Agility:** The computed **Z-value (0.144)** is not statistically significant (**p = 0.885**), indicating no significant improvement in agility for the control group.

Table (15)

Improvement Percentages Between Pre-Test and Post-Test Means for the Control Group in Some Physical Variables Under Investigation (N=8)

Variables	Pre-Test Mean	Post-Test Mean	Improvement Percentage
Muscular Power	152.7500	153.7500	0.7%
Agility	13.1538	13.1525	0.01%

From **Table (15)**, **Muscular Power:** The control group showed a slight improvement of (**0.7%**) in muscular power, **Agility:** The improvement in agility was minimal, at just (**0.01%**), indicating almost no measurable progress.

Table (16)

Significance of Differences Between Experimental and Control Groups in Post-Test Measurements of Some Physical Variables (Using Mann–Whitney Method) (N=16)

Variables	Groups	Mean Ranks	Sum of Ranks	U	Z	P
Muscular Power	Experimental (N=8)	12.50	100.00	0.00	3.363	0.001
	Control (N=8)	4.50	36.00			
Agility	Experimental (N=8)	12.50	100.00	0.00	3.366	0.001
	Control (N=8)	4.50	36.00			

From **Table (16)**, The **Z-values** for both variables are significant at **P ≤ 0.001**, confirming the superiority of the experimental training program in improving these physical variables.

- **Discussion of Results**:

The data in **Table (12)** reveal statistically significant differences between the pre- and post-measurements for the experimental group in the variables of **muscular power** and **agility**, favoring the post-measurements. Meanwhile, **Table (14)** indicates statistically significant improvements in the control group for **muscular power** only, while no significant differences were observed for **agility**. This highlights the superior impact of the training program implemented with the experimental group.

The observed improvements in the experimental group can be attributed to the implementation of the **proposed training program**, which integrates **Tabata training**. This high-intensity interval training method alternates between short bursts of intense effort and brief recovery periods, effectively enhancing fitness components such as **muscular power** and **agility**. These components are critical for taekwondo performance, particularly in the kyorugi category. The training sessions were carefully tailored to suit the age group of the participants, incorporating elements of **engagement and motivation** through a variety of exercises designed for each training unit.

The findings align with those of **Howard Fortner and others (2014)**, who reported that Tabata exercises have a positive effect on developing and improving various fitness elements. Their results demonstrated significant differences between pre- and post-measurements in favor of the latter. (26)

The researcher attributes the improvement observed in the post-test measurements compared to the pre-test measurements to the **structured and well-planned Tabata training exercises** designed specifically for the study's sample. These exercises led to a significant enhancement in both **muscular power** and **agility**.

The importance of **structured training programs** and the incorporation of Tabata training lies in their profound impact on:

- **Improving specific physical performance levels**, particularly for athletes in competitive sports.
- **Enhancing basic skills** by improving movement efficiency and control.

- **Developing tactical foundations**, enabling athletes to execute techniques with greater precision and effectiveness during competition.

This aligns with the findings of several studies, including those by **Sara Mohamed Kamal** (2017) (4), **Shaimaa Abdel Karim** (2017) (5), **Mohannad Mohamed Mounir** (2018) (16), **Marwa Medhat Hassan** (2020) (15), **Noha El-Sayed Darwish** (2021) (18), **Advaita Deepak et al.** (2019) (20), **Mohanakrishnan** (2021) (27), and **Natalia Moskinko et al.** (2021) (28). These studies highlighted the effectiveness of Tabata training programs in positively influencing both muscular power and agility.

This confirms the validity of the first hypothesis, which states: "There are statistically significant differences in certain physical variables specific to Taekwondo (Kyorugi), namely muscular power and agility, between the pre- and post-measurements of both the experimental and control groups, in favor of the post-measurements".

It is evident from Table (16) that there are statistically significant differences between the experimental and control groups in the physical variables, with the post-test measurements favoring the experimental group.

As confirmed by "**Nevin Hussein Mahmoud" (2018)**, combat sports rely on diverse performance techniques, which require athletes to continuously train in positive attack, defense, counter-attacks, and combined attacks. (19: 73)

"Hatem Al-Shlol and others" (2018), see that Taekwondo is a combat sport that demands several physical abilities, which must align with the nature of the performance. They emphasize the crucial role of physical fitness components in performance effectiveness when confronting an opponent. Taekwondo heavily relies on physical fitness and its various components. Therefore, quality training in physical fitness is inseparable from skill and tactical training in Taekwondo. Coaches today use various methods in physical training and are even dedicated to establishing scientific theories and foundations for sports training, aiming to develop a well-rounded athlete ready for competitive events. (3: 1195)

This aligns with the studies of **"Mohamed Magdy Amara" (2015) (13), "Shaima Abdel Karim" (2017) (5), "Karim Mustafa Benoy" (2018) (9), "Mahmoud Said Ibrahim" (2018) (14),** and **"Maher Ahmed Al-Essawi et al". (2017) (10),** which found statistically significant

differences between pre-test and post-test measurements in the experimental group as a result of the training program. Based on this, the researcher concludes that these studies corroborate her findings, establishing a correlational relationship between Tabata training and physical performance improvement.

This supports the validity of the second hypothesis, which states: "There are differences between the post-test measurements of some physical variables between the pre- and post-test measurements, favoring the experimental group."

It is evident from Tables (13 and 15) that the improvement percentages between the pre-test and post-test measurements favored the post-test measurements for the experimental group in some of the physical variables under investigation. The improvement percentages for the experimental group ranged between (2.9% and 13.4%), while for the control group, the improvement percentages ranged between (0.01% and 0.7%).

"Ghada Atef Said" (2010) indicates that taekwondo is characterized by powerful and fast movements, with a variety of basic, secondary, and combined movements, making physical fitness play a significant role in earning points in matches. The skillful and tactical performance is enhanced by improving physical fitness elements. Furthermore, taekwondo movements are marked by strength, speed, and endurance to maintain these levels.

Additionally, **"Ghada Atef Said" (2010),** quoting **"Mohammad Ali & Hamidreza Barnamehei" (2017),** emphasizes that endurance is a crucial component in taekwondo, relying on physical fitness. The effort exerted by athletes during training and competitions places a physical, nervous, and psychological strain on the body's organs, which is reflected in the phenomenon of fatigue. (6: 32)

This is consistent with the studies of "**Sara Mohamed Kamal"** (2017) (4), "**Shaimaa Abdel Karim"** (2017) (5), "**Mohannad Mohamed Muneer"** (2018) (16), "**Marwa Medhat Hassan"** (2020) (15), "**Naha El-Sayed Darwish"** (2021) (18), "**Advita Deepak et al."** (2019) (20), "**Mohanakrishnan"** (2021) (27), and "**Natalia Moskiniko et al."** (2021) (28), which highlighted the effectiveness of Tabata training programs in positively affecting certain physical variables during competitions, to the advantage of the experimental group.

This supports the validity of the third hypothesis, which states: "There are improvement percentages in certain physical variables between the pre-test and post-test measurements for both the experimental and control groups, favoring the experimental group."

- **Conclusions:**

In light of the research objectives, hypotheses, the sample used in the primary study, its characteristics, the methodology applied, and through statistical data analysis and the results obtained and discussed, the following conclusions can be drawn:

1. The proposed training program using Tabata exercises has a positive effect on developing the levels of muscular strength and agility, as observed in the experimental group of taekwondo athletes in the specific research variables.
2. The proposed training program using Tabata exercises has an effect on the muscular strength variable, while it was not statistically significant for the agility variable in the control group of taekwondo athletes.
3. The inclusion of Tabata exercises in the training program led to improvements in both muscular strength and agility in the experimental group, with improvement percentages in the pre-test and post-test measurements ranging between (2.9% and 13.4%).
4. The inclusion of Tabata exercises in the training program also led to improvements in muscular strength and agility in the control group, but the improvement percentages in the pre-test and post-test measurements ranged between (0.01% and 0.7%).

- **Recommendations:**

Based on the results obtained by the researcher after completing the training program, the following recommendations are made:

1. Use of Tabata exercises within training programs for preparing athletes, particularly during the preparation period for competitions.
2. Conduct more similar studies to develop physical fitness components for taekwondo across different age groups.
3. Implement the proposed program on male taekwondo athletes in the specific event, to evaluate its impact on performance.
4. Focus on Tabata training, due to its significant effect on improving both physical and skill performance levels.

5. Monitor changes in athletes during high-intensity training sessions and develop appropriate training programs based on the intensity and the athletes' capacity.

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