

## Effect of Tabata Protocol Workouts on Some Physical and Physiological Variables and the Level of Technical Performance of Thomas Flair on Pommel Horse

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### Abstract

*This research aims to identify the effect of Tabata protocol workouts on some physical and physiological variables and the level of technical performance of Thomas flair on pommel horse apparatus in gymnastics. The researcher used the experimental design for pre-post measurement of one group to suit the nature of the research. The research sample was chosen Intentionally from the gymnastics team players at Qassim University, and the basic research sample included (10) players, while the exploratory study was conducted on a sample of players representing the original community, from outside the main research sample, their number was (10) players who were chosen randomly with the aim of selecting the appropriate Tabata protocol workouts and codifying it's training loads. the most important results were as follows: The percentage of improvement for the physical variables ranged between (11.7%, 52.1%), and the highest percentage of improvement was for the (legs muscular power) by (52.1%), and the lowest percentage of improvement was for (back muscles strength) by (11 ,7%), and the percentage of improvement of the rest elements ranged between them, while the percentage of improvement of physiological variables ranged between (2.9%, 37.1%), and the highest percentage of improvement was for the anaerobic ability variable by (37.1%), and the lowest percentage of improvement was for the rest pulse rate by (2.9%). While the percentage of improvement for the technical variable (Thomas Flair) by (34.6%). The researcher recommends using Tabata protocol workouts to develop physical, physiological fitness and the level of technical performance of Thomas Flair's skill on the pommel horse apparatus in gymnastics.*

### Introduction and Research Problem:

Gymnastics depends on high-level technical performance, in defiance of the forces of nature, which requires exceptional physical abilities. Therefore, the level of achievement of the gymnast is directly related to the extent of the physical abilities that he possesses to enable him to perform this performance.

Artistic gymnastics competitions require a great variety of dynamic and static skills, with control of body positions against gravity, in addition to some skills that require strength, flexibility and balance. (Atilgan, O. E. 2013: 16)

Advanced countries in gymnastics are interested in planning to prepare the gymnast in a comprehensive and balanced manner, especially physical abilities, so that it can meet the new skill requirements on different apparatuses. (Al-Hadi, A. 2017: 291)

Performance requirements on gymnastics apparatuses are considered one of the most important components of building training programs, physical requirements are one of the most important requirements that have been addressed by many researches and studies. Which is concerned with the development of methods of physical preparation, muscular ability and maximum strength are of great importance in many sports performances as a basic physical requirement. (Abdel-Baseer, A. 2019: 18)

Developing physical components is preferable to be appropriate for the type of muscle work, in order to raise the physical level of the player to the maximum extent permitted by his abilities to achieve high levels of technical performance. (Schultz, G. W. 2017: 84); (Baumgartner, T. A., & Jackson, S.J. 2012: 54)

Modern technologies invaded our daily life as well as our sports life in order to highlight the best of the player's natural human abilities through improving performance and developing training methods that the player and coach depend on in developing technical performance. (Shehata, M. 2019: 34)

Among the training methods that have emerged recently for the development of physical fitness is the Tabata Protocol training method, where the training load of this method was formed by the Japanese Professor Izumi Tabata and a team of researchers from the National Institute of Fitness and Sports from Ritsumeikan University in Tokyo to train Japanese speed skaters and is applied in many Training programs so that the time for performing the exercise is for (20) seconds with high intensity, followed by (10) seconds of positive rest, and the exercise is repeated (8) groups, bringing the time for performing groups of each exercise to (4) minutes, in a session extending to (20) minutes, It improves physical fitness and aerobic and anaerobic ability. **(Tabata, I., et al., 1996: 1327)**

Tabata training is a term often used synonymously with High Intensity Interval Training (HIIT). Tabata workouts are considered one of the best training methods that are characterized by ease, simplicity and high results, and do not need equipment or a special place for training or a large amount of time for training. **(Emberts, T., et al., 2013: 612); (Tabata, I., et al., 1997: 390)**

Tabata protocol is a form of high-intensity interval training that performs in a short period of time, and is applied in many training programs in a number of diverse sports, and can be combined with other training methods, as it can raise fitness rates and aerobic and anaerobic ability together. **(Olson, M., 2014: 19)**

Rationing the training load in the Tabata protocol depends on a high training intensity, and the load size is up to five groups, so that the performance is for a period of (20) seconds with high intensity, followed by (10) seconds of positive rest, for a period of time up to (4) minutes for one group, with a total Time (20-30) minutes of the training unit time. **(Chapoton, B., 2015: 474)**

There are a variety of performance methods when applying the Tabata protocol, but all of them are characterized by periods of intense effort with incomplete rest periods, and among the most used training programs for the Tabata protocol are cycling, running, rowing and resistance training using body weight. **(Miller, L., et al., 2015: 292)**

Tabata training 8-20 minutes (20 seconds max effort, 10 seconds rest, 8 repetitions within 4 minutes, with 1-minute rest between sets) Using Tabata training for 6 weeks, aerobic fitness improved to the same degree when compared to continuous load training for 30 minutes. **(McRae, G., 2012: 1124)**

Tabata training is more effective and time-saving than traditional training methods, and controlling the rest time to work time is easy to apply to develop both aerobic and anaerobic ability. **(Foster, C., et al., 2015: 747); (Rebold, M., et al., 2013: 3419)**

Despite the effect of these workouts to raise physical and skill efficiency, there is still a very small amount of studies related to the effectiveness of using Tabata workouts in various sports activities. **(Fortner, H. et al., 2014: 179)**

Through the researcher's work as an assistant professor in the department of physical education and movement sciences - Qassim University, and technically responsible for the men's artistic gymnastics team at the same university, the researcher noticed some faults in the level of technical performance when executing Thomas Flair's skill on pommel horse apparatus, where the implementation of the skill understudy depends on two main groups of muscles, the first group is the arms and the shoulder and its responsibility is to maintain the motor balance during the implementation of the Thomas Flair skill, and the second group is legs muscles, which is the driving energy and the main outlet for the skill, which requires the player to exploit the kinetic energy resulting from legs rotation with maintaining body position while moving among the

parts of pommel horse, and then implementing the skill understudy in a correct technique, from here the research problem appeared, as the researcher noticed some defects in the players' ability to perform Thomas Flair skill on pommel horse understudy, which appeared in many competitive situations, which negatively affects the total score of the player on a pommel horse apparatus.

Where the rebates for the formal defects of performance range between (0.1 - 0.3 - 0.5) of the degree according to the type of defect, and the rebate may reach (1 full degree) in case of the player lose his balance and falls during the performance of the basic technical stage of the skill and thus his inability to compete for a medal, the researcher noticed the repetition the same technical defects of the players on the pommel horse apparatus, in the technical skill understudy, and this was clear through the competitive and evaluation situations. Because of its importance in carrying out the motor duty in the required technical form, which affects the player's score on the apparatus understudy.

The routine on the pommel horse apparatus is characterized by the different shapes of the circular leg swings with joining or opening legs in different fulcrum positions and on all parts of the pommel horse. It also allows swings while passing or performing dismounts from a handstand position, with or without twisting around the longitudinal axis. All skills should be performed with full swing and without any pauses, strength and stability skills are not allowed, International Gymnastics Federation defines the motor groups on pommel horse apparatus as follows:

Table (1): Technical groups on pommel horse apparatus

	Groups	Difficulty						Skills	%
		A	B	C	D	E	F		
<b>G1</b>	Single leg swings and scissors	4	5	5	5	-	-	19	16.2%
<b>G2</b>	Circles and flairs, with and/or without spindles and handstands	10	18	8	7	6	2	51	43.5%
<b>G3</b>	Side and cross support move	3	8	12	12	-	-	35	29.9%
<b>G4</b>	Dismounts	1	4	3	3	1	-	12	10.2%

(G.I.F. 2020: 54)

It is clear from Table (1) the relative importance of the skills of the second group, including the skill of Thomas Flair on pommel horse understudy. This group contains 51 skills, with a percentage 43.5% of the total skills on pommel horse apparatus. This group also includes (6 skills of difficulty E, and two skills of difficulty F) which are considered the highest difficulty on pommel horse, which reflects the importance of Thomas Flair's skill which located at the second group on the pommel horse understudy.

Through the researcher's follow-up to the tremendous development in training methods, a new method of training has recently appeared, which is the Tabata Protocol, as one of the forms of high-intensity interval training (HIIT), to raise physical, physiological and skill efficiency, as its performance is characterized by enthusiasm and not feeling bored, and it is also considered a new method of developing physical and functional abilities, especially the presence of compatibility between the formation of the training load for Tabata workouts and the time of performing the technical routine on pommel horse apparatus, which ranges between (30-40 seconds).

By reviewing the researcher's studies related to gymnastics, the researcher noticed a dearth of training programs using Tabata exercises, especially on the pommel horse apparatus, which requires conducting an empirical study as an attempt to develop the level of technical performance of the players on the pommel horse apparatus understudy. Therefore, the researcher resorted to designing and codifying a group of workouts using the Tabata Protocol, to identify its

effect in developing some physical and physiological variables and the level of technical performance of Thomas Flair's skill on pommel horse, and thus raising the scores of the players under study.

**Research Goals:**

Identifying the effect of Tabata protocol workouts on technical performance of Thomas flair on pommel horse apparatus in gymnastics for the members of the research sample, through:

- Developing some physical variables for the members of the sample under study.
- Developing some physiological variables and the level of technical performance of Thomas flair on pommel horse apparatus under study.

**Research Hypothesis:**

- There are statistically significant differences between pre & post measurements of the experimental group in the physical variables under study in favor of the post measurement.
- There are statistically significant differences between pre & post measurements of the experimental group in the physiological variables and in the level of technical performance of Thomas flair on pommel horse apparatus under study in favor of the post measurement.

**Research Terms:**

- **Tabata Protocol**

A training method designed by Japanese Professor Izumi Tabata. It is a form of high intensity interval training (HIIT), that is characterized by short performance time (20) seconds, positive rest for (10) seconds, continuation for (4) minutes, and repetition (8) sets, and it can be applied according to the specific goal. program whether to improve muscular strength or aerobic endurance. (Miller, L., et al., 2015: 293)

**Research Procedures:**

- **Research Methodology:**

The researcher used the experimental method using the experimental design of one group and by making the two measurements (pre-post).

- **Spatial Domain:** gymnastics hall - halls complex at Qassim University - Buraidah City - Kingdom of Saudi Arabia.

- **Time Domain:** The exploratory study was conducted in the time period from Sunday 19/12/2021 to Tuesday 28/12/2021, and the pre-measurement was conducted on Thursday, 30/12/2021. The basic study was carried out during the period from Sunday, corresponding to 2/1/2022, until Thursday, corresponding to 24/3/2022, and the post-measurement was conducted on Sunday, corresponding to 27/3/2022.

- **Research Sample:**

The sample of the basic study was chosen intentionally from the gymnastics team players at Qassim University, and the sample included (10) players, while the exploratory study was conducted on a sample of players representing the original community and from outside the basic research sample, and their number reached (10) players who were chosen randomly with the aim of selecting suitable Tabata Protocol workouts related to the technical skill under study, and codify the training load of these exercises.

**Statistical description of sample**

Table (2): Statistical description of growth rates variables (Height - Weight - Age - Training Age) (n=10)

	Statistical data Variables	measuring unit	Mean	standard deviation	Median	Coefficient of torsion
<b>Growth rates</b>	1 Tall	cm	170.1	1.911	170	0.156
	2 Weight	Kg	68.18	0.981	68.15	0.091
	3 Age	Year	19.48	0.654	19.45	0.137
	4 Training age	Year	15.2	0.745	15.15	0.201

From Table (2) it is clear that the values of the torsion coefficient for each of the growth rates variables understudy ranged between (0.091, 0.201) and these values were limited between ( $\pm 3$ ) which indicates the moderation of the values of the growth rates of the individuals in the sample understudy before experimenting.

Table (3): Statistical description of physical variables (n = 10)

Variables	Test	measuring unit	Mean	standard deviation	Median	Coefficient of torsion
<b>Agility</b>	Zigzag run	s	7.158	0.202	7.175	- 0.252
<b>Back strength</b>	Dynamometer	Kg	122.4	1.825	122.2	0.279
<b>Muscular power</b>	Sargent test	cm	49.48	1.295	49.85	- 0.857
<b>Dynamic Balance</b>	Bass test	degree	71.83	1.810	71.2	1.043

From Table (3) it is clear that the values of the coefficient of torsion for each of the physical variables understudy ranged between (- 0.857, 1.043) and these values were limited between ( $\pm 3$ ) which indicates the moderation of the values for the physical variables of the sample individuals understudy before experimenting.

Table (4): Statistical description of physiological & technical variables (n = 10)

Variables	Test	measuring unit	Mean	standard deviation	Median	Coefficient of torsion
<b>vo<sub>2</sub>max</b>	Cooper test	ml/kg/min	45.27	0.581	45.05	1.135
<b>Vital Capacity</b>	Spirostik	Liter	4.368	0.259	4.3	0.785
<b>Anaerobic ability</b>	Sargent test	kg.m/s	932.5	1.723	932.7	- 0.226
<b>Rest pulse rate</b>	Polar watch	pulse/min	69.24	1.331	69.2	0.090
<b>Technical variable</b>	Thomas Flair	degree	6.64	0.419	6.65	- 0.071

From Table (4) it is clear that the values of coefficient of torsion for each of the physiological & technical variables understudy ranged between (- 0.226, 1.135) and these values were limited between ( $\pm 3$ ) which indicates the moderation of the values for physiological & technical variables of the sample individuals understudy before experimenting.

**Means of data collection:**

The researcher used the following methods to collect data:

- Means of collecting data related to anthropometric measurements.
- Means of collecting data related to physical variables.
- Means of collecting data related to physiological variables.
- Means of collecting data related to technical variable.

**Means of collecting data related to anthropometric measurements:**

The means and tools for data collection that are appropriate to the nature of the study were identified by looking at the scientific references, research and previous studies in the field of gymnastics training and some other sports. The researcher has used the following tests, measures

and devices:

- A rest-meter device for measuring the total length of the body up to the nearest 1 cm.
- The medical scale device to measure the student's weight up to the nearest 1 kg.

**Means of collecting data related to physical variables understudy:**

Physical Variables Tests understudy attachment (6)

- Agility (zigzag run test).
- Back muscular strength (Dynamometer).
- Legs muscular power (Sargent – vertical jump test).
- Dynamic balance (modified bass test)

**Means of collecting data related to physiological variables understudy:**

physical physiological tests understudy attachment (7)

- $VO_2$ max (cooper test – 12min/run).
- Vital Capacity (Spirostik).
- Anaerobic ability (Sargent test + Apply special equation).
- Rest pulse rate (Polar watch)

**Means of collecting data related to technical variable.**

The technical skill understudy was filmed using the "video camera" and the videos were shown to four arbitrators accredited by the Egyptian Gymnastics Federation to evaluate the technical performance of the skills understudy, where each rule monitored a score of ten degrees for each technical skill on pommel horse apparatus understudy, and was deleted The highest and lowest score for a player's score is the average of the two middles.

Subjective Evaluation is the type of evaluation that does not depend on the standards, levels, and criteria, but depends on the experiences of the measurers (arbitrators), and the legal evaluation is used in many of sports activities, especially gymnastics, diving, rhythmic gymnastics and water ballet, where uniform international legal conditions are established, agreed upon in advance between the arbitrators, so that the greatest degree of objectivity can be reached in assessing the degree. (Khalil, M. 2020: 9); (Hassanein, M. 2015: 42)



Figure (1):Thomas Flair Skill understudy

**Selecting the assistants:**

A number of (2) assistants from the department of Physical Education & Movement Sciences, were chosen to assist the researcher in applying the study procedures.

**The Exploratory Study:**

The researcher conducted the exploratory study in the time period from Sunday 19/12/2021, to Tuesday 28/12/2021, on a sample of players representing the original community and from outside the main research sample, and their number reached (10) players who were chosen randomly. Pre-measurement was carried out on Saturday, 30/12/2021.

**This study has targeted:**

- Ensure the safety of the devices and tools used
- Discovering and handling difficulties while making measurements.
- Training assistants to take measurements and ensure that tests are applied according to the specified conditions
- Selecting and experimenting with Tabata protocol workouts and their suitability for the technical skill understudy.
- Rationing of training load variables for Tabata protocol workouts understudy.
- Conducting scientific transactions for the tests used (validity and reliability) and ensuring their suitability for the research sample.
- Adjust the best angle of shooting with the camera to facilitate the process of assessing the technical performance of the skills understudy.

**The Exploratory Study resulted in:**

Ensure that all of its objectives are achieved, and that the suggested workouts understudy are appropriate for the nature of the sample age, as the members of the exploratory sample performed the suggested Tabata protocol workouts without any difficulties, which made the researcher the possibility of applying these workouts to the individuals of the basic research sample.

**• Scientific Transactions:**

**- Validity coefficient**

The researcher calculated the validity coefficient using the method (validity of differentiation), between two groups, one distinguished and numbered (5) players, and the other less -distinguished numbered (5) players, from the same research community and from outside the basic research sample, in order to calculate the validity coefficient of the physical and technical tests understudy, as shown in Table No. (5)

Table (5): Differentiation validity of physical and technical tests understudy n1=n2=5

Variables	Test	Measure unit	distinguished group		less distinguished group		difference mediocre	T test
			Mean	St.D.	Mean	St.D.		
Agility	1 Zigzag run	s	7.002	1.138	7.314	0.109	0.312	3.947*
Back strength	2 Dynamometer	Kg	123.82	1.346	121.02	0.884	2.800	3.887*
Muscular power	3 Sargent test	cm	50.460	0.477	48.50	1.070	1.960	3.740*
Dynamic Balance	4 Bass test	degree	73.28	1.397	70.38	0.408	2.90	4.455*
Technical performance	5 Thomas Flair	degree	6.96	0.207	6.32	0.311	0.64	3.825*

Tabular T value at a significant level of 0.05 = 1.860 on one side \* = significant

It is clear from Table No. (5) and by applying the “T” test to calculate the significance of the differences between two independent groups, one distinguished and the other less -distinguished, that the calculated “T” value, which was limited to (3.740, 4.455), is greater than the tabular “T” value at a significant level. (0.05), which amounted to (1.860), which indicates that there are statistically significant differences between the two groups in favor of the distinguished group, which confirms the validity of the tests understudy in what they were designed to measure, and that they can differentiate between the distinguished and less -distinguished players of the same age group.

**- Reliability Coefficient**

The reliability coefficient was calculated using the method of applying and reapplying the test (Test - Retest), for the physical and technical tests under study, the first application of the tests was conducted on 23/12/2021 on a sample of (10) players. While the second application took place on 30/12/2021, with an interval of 6 days. And calculate the correlation coefficient between them, as shown in Table (6).

Table (6): Reliability coefficient of physical and technical tests under study n=10


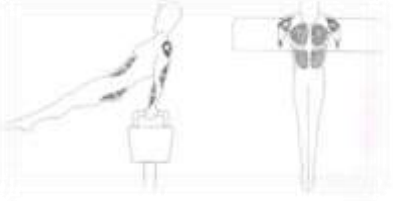
Variables	Test	Measure unit	TEST		RE-TEST		Correlation Coefficient
			Mean	St.D.	Mean	St.D.	
Agility	1 Zigzag run	s	7.158	0.202	7.093	0.197	0.979*
Back strength	2 Dynamometer	Kg	122.4	1.825	126.8	1.461	0.729*
Muscular power	3 Sargent test	cm	49.48	1.295	49.88	1.301	0.809*
Dynamic Balance	4 Bass test	degree	71.83	1.810	72.13	1.938	0.915*
Technical performance	5 Thomas Flair	degree	6.64	0.419	6.80	0.454	0.976*

Tabular value "r" at the level of significance 0.05 = 0.564 on one side \* = significant

It is clear from Table (6) that the values of "r" of physical and technical tests under study ranged between (0.729, 0.979), which is greater than the tabular value of "r" at the level of significance (0.05), which amounted to (0.564), which indicates the existence of a relationship a statistically significant correlation between the Test & Re-test, which confirms the reliability of the tests under study.

- Basics of design the program
- Determining the working muscles of Thomas Flair's skill on pommel horse:

Table (7): Working muscles of Thomas Flair's skill under study

Motor muscles	Supporting muscles
 <ul style="list-style-type: none"> <li>• Leg muscles</li> </ul> <p>Its main role: the driving force of skill</p>	 <ul style="list-style-type: none"> <li>• Arm &amp; shoulder muscles</li> <li>• Trunk muscles</li> </ul> <p>Its main role: to maintain the integrity of the body and stability while moving on the parts of the pommel horse.</p>

(G.I.F. 2020: 56)

- Determining the special physical variables of pommel horse:

Table (8): Special physical variables of pommel horse

	Physical variables	Measure unit	Percentage
1	Agility	degree	95.46%
2	Back strength	degree	90.91%
3	Muscular power	degree	86.37%
4	Dynamic Balance	degree	81.82%
5	Flexibility	degree	77.72%



6	Motor Speed	degree	72.73%
7	General Endurance	degree	68.18%
8	Muscular Endurance	degree	63.64%

(Youssef, A., et al., 2021: 9)

It is clear from table (8) that the arrangement of the physical variables on pommel horse according to a survey to experts & specialists.

• **Suggested Tabata Protocol workouts:**

The researcher applied a group of Tabata protocol workouts attachment (8) that correspond to the motor paths of the technical skill on pommel horse apparatus understudy. The workouts are divided into:

- 1- Tabata protocol workouts for legs muscles.
- 2- Tabata protocol workouts for arms muscles.
- 3- Tabata protocol workouts for torso and the whole body.

The researcher also took into account when designing these workouts, the following:

- It should contain the basic stages of Thomas Flair's skill understudy or some of its parts.
- Simulating the actual performance of skill in terms of strength, speed, direction of movement, and accuracy of performance.
- Codify the Tabata protocol workouts to determine the maximum intensity for each exercise.
- Gradual workouts from easy to difficult and from simple to complex with its diversity.

• **Training load variables for the proposed Tabata protocol workouts:**

The researcher has codified the training load variables for the proposed fitness Tabata protocol workouts by reviewing previous and related studies, specialized references, sports training science references and the international information network. attachment (9)

1- **Intensity:**

The researcher relied on calculating pulse rates to determine the intensity of the training load Using the Carvonein equation to calculate the Target Pulse Rate (TPR)

$$TPR = \text{resting pulse rate} + \text{target load intensity} \times (\text{heart rate reserve})$$

Table (9): Intensity Percentage

load degrees	Percentage	Pulse Rate
Medium	50 : 74%	130 : 150 p/m
high	75 : 84%	150 : 170 p/m
Maximum	85 : 100 %	170: 200 p/m

The researcher took into account the gradual increase in the intensity through the gradual control of its variables, and the times of the training loads were organized and distributed over the training weeks and the appropriate degrees of load during the period of workouts application.

2- **Volume, (Repetitions – Sets):**

Tabata protocol workouts were applied in the main part of the training unit, and the exercise performance time was for (20) seconds with high intensity, followed by (10) seconds of positive rest, and the exercise was repeated (8) groups, bringing the time for performing groups of each exercise to (4) minutes, rest after each exercise, (1) minute in a session extending to (20) minutes.

3- **Rest Periods:**

Determining the appropriate intermittent rest time after performance based on Tabata protocol, the exercise performance time was for (20) seconds with high intensity, followed by

(10) seconds of positive rest.

• **Program Duration:**

- The duration of the training program was (12 weeks), with 3 training units per week.
- The researcher determined the time of the training unit in the week with an average load between (90 - 120 min), taking into account the wavy load between the training units.
- The time of Tabata- protocol workouts within the training unit was on average (20) minutes. The load intensity used (high intensity).

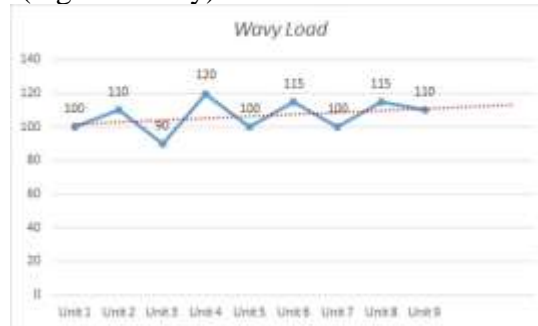


Figure (2): Wavy Load of training units

The distribution of training load degrees over the training weeks during the stages of the training program to the degree of the average load between (50 -74%), the high load between (75 - 84%) and the maximum load between (85 - 100%).

• **The stages of applying the suggested Tabata protocol exercises:**

Table (10): Stages of applying Tabata protocol exercises

Stages	Weeks	Units/ week	unit time	Load Cycle
First stage	3			
Second stage	4	3	90 - 120 minutes	1 : 2
Third stage	5			

**Training methods:**

The researcher used: High-intensity interval training (HIIT)

**Training Load Cycle:**

Formation the training load cycle on units was chosen using the way of training load (1 : 2), which means a medium load for one unit, followed by a high load in the following two units.

**Basic study:**

The basic study was carried out during the period from Sunday, 2/1/2022, until Thursday, 24/3/2022, and the post-measurement was conducted on Sunday, 27/3/2022, and the pre & post technical performance was filmed at the gymnastics hall in Sports halls complex. on the campus of Qassim University. As shown in the time distribution table of research application, attachment (10).

**Statistical Treatments:**

The researcher used the program (Statistical Package for Social Sciences) (SPSS v25) Using the following statistical parameters:

Mean - Standard Deviation – Median - Torsional coefficient – Wilcoxon test - Percentage of improvement.

**Presentation and discussion of the results:**

**Present the results:**

**Presenting the results of the first hypothesis:**

Table (11): Significance of differences between pre & post measurements for the experimental group in physical variables understudy n = 10

Physical Variables	Test	Pre mean	Post mean	Positive ranks		Negative ranks		(Z) Value
				mean rank	Sum of ranks	mean rank	Sum of ranks	
Agility	1 Zigzag run	7.158	5.858	0.00	0.00	5.5	55	-2.805*
Back strength	2 Dynamometer	122.42	136.72	5.5	55	0.00	0.00	-2.803*
Muscular power	3 Sargent test	49.48	75.28	5.5	55	0.00	0.00	-2.805*
Dynamic Balance	4 Bass test	71.83	90.53	5.5	55	0.00	0.00	-2.803*

\*Tabular value (Z) at the level of 0.05 = ± 1.96

From Table (11) it is clear that the calculated value of (Z) for each of the physical variables understudy has ranged between (-2.805, -2.803) and these values are not limited to (± 1.96) which indicates the presence of statistically significant differences. between the mean of the pre-post measurements of the experimental group in favor of the post measurement at the level of significance (0.05) in the physical variables understudy.

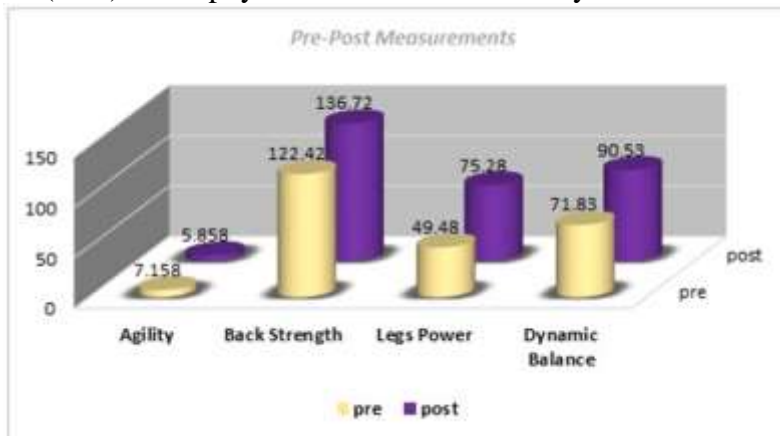


Figure (3): Significance of differences between pre & post measurements for the experimental group in physical variables understudy

Table (12): Percentage improvement of the experimental group in physical variables understudy

Physical Variables	Test	Pre mean	Post mean	Means Difference	Percentage of improvement
<b>Agility</b>	1 Zigzag run	7.158	5.858	1.3	18.2%
<b>Back strength</b>	2 Dynamometer	122.42	136.72	14.3	11.7%
<b>Muscular power</b>	3 Sargent test	49.48	75.28	25.8	52.1%
<b>Dynamic Balance</b>	4 Bass test	71.83	90.53	18.7	26.0%

From Table (12) it is clear that the percentage of improvement of the experimental group in the physical variables understudy ranged between (11.7%, 52.1%) and the highest percentage of improvement was for the variable of muscular power (legs muscular power) by (52.1%), and the lowest percentage of improvement was for the variable of back strength by (11.7%), and the percentage of improvement of the rest variables ranged between them.

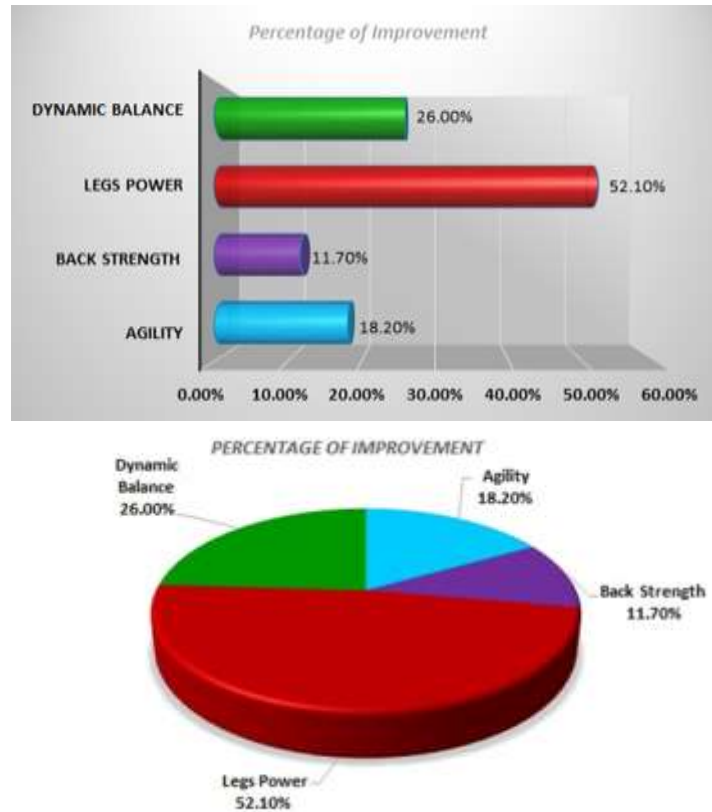


Figure (4): The percentage improvement in the physical variables under study

**Presenting the results of the second hypothesis:**

Table (13): Significance differences between pre & post measurements for the experimental group in physiological & technical variables under study n = 10

Physical Variables	Test	Pre mean	Post mean	Positive ranks		Negative ranks		(Z) Value
				mean rank	Sum of ranks	mean rank	Sum of ranks	
vo <sub>2</sub> max	1 Cooper test	45.27	51.58	5.5	55	0.00	0.00	-2.807*
Vital Capacity	2 Spirostik	4.068	5.268	5.5	55	0.00	0.00	-2.666*
Anaerobic ability	3 Sargent test + equation	932.57	1278.27	5.5	55	0.00	0.00	-2.803*
Rest pulse rate	4 Polar watch	69.24	67.26	0.00	0.00	5.5	55	-2.601*
Technical variable	5 Thomas Flair	6.46	8.94	5.5	55	0.00	0.00	-2.809*

\* Tabular value (Z) at the level of 0.05 = ± 1.96

From Table (13) it is clear that the calculated value of (Z) for physiological & technical variable under study has ranged between (-2.809, -2.601) and these values are not limited to (± 1.96) which indicates the presence of statistically significant differences. between the mean of the pre-post measurements of the experimental group in favor of the post measurement at the level of significance (0.05) in physiological & technical variables under study.

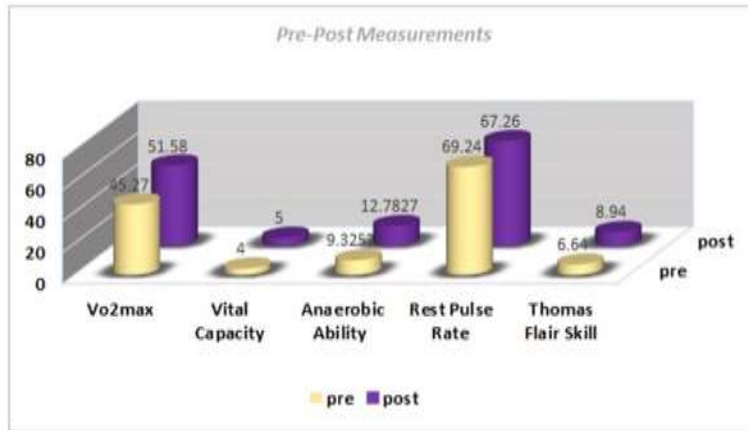
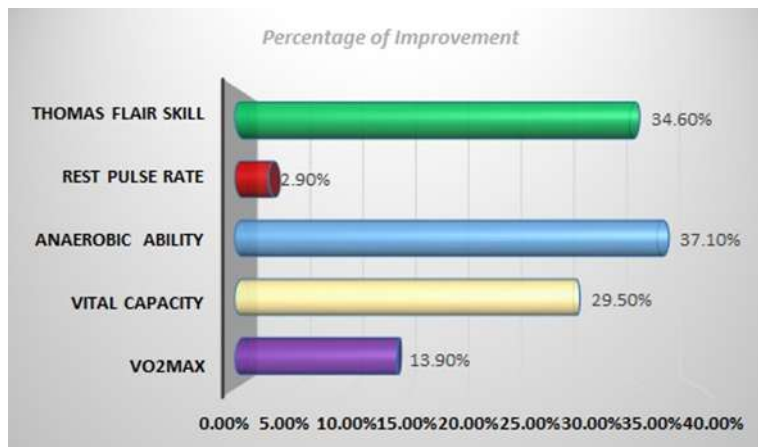


Figure (5): Significance differences between pre & post measurements for the experiment group in physiological & technical variables under study

Table (14): Percentage improvement of the experimental group in physiological & technical variables under study

Physical Variables	Test	Pre mean	Post mean	Means Difference	Percentage of improvement
vo2max	1 Cooper test	45.27	51.58	6.31	13.9%
Vital Capacity	2 Spirostik	4.068	5.268	1.20	29.5%
Anaerobic ability	3 Sargent test + equation	932.57	1278.27	345.7	37.1%
Rest pulse rate	4 Polar watch	69.24	67.26	1.98	2.9%
Technical variable	5 Thomas Flair	6.64	8.94	2.30	34.6

From Table (14) it is clear that the percentage of improvement of the experimental group in physiological & technical variables under study ranged between (2.9%, 37.1%) and the highest percentage of improvement was for the variable of muscular Anaerobic ability by (37.1%), and the lowest percentage of improvement was for the variable of rest pulse rate by (2.9%), and the percentage of improvement of the rest variables ranged between them.



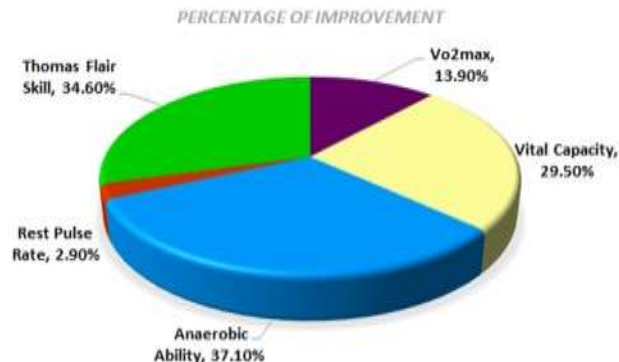


Figure (6): Percentage improvement of the experimental group in physiological & technical variables understudy

### Discuss the results:

#### Discussing the results of the first hypothesis:

Which states, "There are statistically significant differences between the pre and post measurements of the experimental group in the physical variables understudy in favor of the post measurement."

It is clear from Table No. (11) and Figure No. (3) that there are statistically significant differences at the level (0.05) between the pre and post measurements of the experimental group in favor of the post measurement in the physical variables understudy, where the tabular (Z) value was at the level of  $0.05 = (\pm 1.96)$ , while the calculated (Z) values for the physical variables understudy ranged between (-2.805, -2.803) and that all of these values are less than (-1.96), meaning that they are not limited to between  $(\pm 1.96)$ , which indicates the existence of statistically significant differences between the means of pre & post measurements of the experimental group in favor of the post-measurement at the level of significance (0.05) in physical variables understudy. The researcher attributes these results to the effect of Tabata protocol workouts used, and the regularity of training weekly at a rate of (3) training units per week.

It is also evident from Table No. (12) and Figure No. (4) that there are statistically significant differences between the pre and post measurements of the experimental group in favor of the post-measurement in the physical variables understudy, with percentage of improvement that ranged between (11.7%, 52.1%) and the highest percentage of improvement was for the variable of muscular power (legs muscular power) by (52.1%), and the lowest percentage of improvement was for the variable of back strength by (11.7%), and the percentage of improvement of the rest variables ranged between them..

In light of the previous improvement rates, it was found that the proposed Tabata protocol workouts had an positive effect on physical variables understudy for the players, as Tabata protocol workouts were characterized by specific goals and diverse and interesting methods that motivate the players to continue training, as the researcher took into account the rationing the training loads according to the players' capabilities, taking into account individual differences and gradation when implementing, adjusting rest periods to give the body's systems an opportunity to adapt, and applying the principle of privacy in training that takes into account the specificity of muscular work, the form and path of motor performance, and the prevailing energy system. The researcher took into account the training of motor muscles as well as the supporting muscles, for balanced muscle development, without defect the technical performance

and to avoid injuries.

The researcher attributes the positive effect on the physical variables understudy (agility, back muscles strength, leg muscular power, motor balance) to the Tabata protocol workouts used, where the researcher took into account, during the design of the exercises, the diversity of muscular work directions, and the employment of physical variables in the motor paths of the technical skill understudy, which contributed to the development of the physical fitness of the research sample members.

Developing physical components is preferable to be appropriate for the type of muscle work, in order to raise the physical level of the player to the maximum extent permitted by his abilities to achieve high levels of technical performance. (Schultz, G. W. 2017: 84); (Baumgartner, T. A., & Jackson, S.J. 2012: 54)

Gymnastics is depending on long-term planning to prepare the gymnast in a comprehensive and balanced manner, especially physical abilities, to help the gymnast to meet the new skill requirements on different apparatuses. (Al-Hadi, A. 2017: 291)

The highest percentage of improvement for the ability component (muscular ability of the muscles of the legs) came by (52.1%). In this regard, (Abdel-Baseer, A. 2019: 18) adds that the performance requirements on gymnastics apparatuses are considered one of the most important components of building training programs, physical requirements are one of the most important requirements that have been addressed by many researches and studies. Which is concerned with the development of methods of physical preparation, muscular ability and maximum strength are of great importance in many sports performances as a basic physical requirement.

The researcher also attributes these statistically significant differences between the average of the pre and post measurements and the percentages of improvement in the physical variables understudy (agility, back muscles strength, leg muscular power, motor balance) to the positive effect of the various Tabata protocol workouts for all muscle groups in the body, which in turn led to an improvement in the physical variables understudy, and in this regard, (Shehata, M. 2019: 34) indicates that regular training causes several physiological changes to the muscle, represented by an increase in the size of the muscle fibers, and thus increasing the ability of the nervous system to produce the contraction of the fibers, which leads to an increase in the strength and speed of muscle contractions.

The researcher attributes the improvement of motor balance to the selection of Tabata protocol workouts appropriate to the nature of skill performance, and this is consistent with what was indicated by (Nabil, W. 2005: 11) that balance is one of the variables that can be acquired through continuous training with the aim of doing a movement or skill automatically in its performance, and focus workouts on neuro stimulation to control body balance.

These results are in agreement with the results of the studies of (Hussein, Sally. 2022: 247); (Gharib, F. 2021: 428) and (Solaiman, M. 2021: 291) on the positive effect of various Tabata workouts on improving physical fitness variables such as agility, core muscle strength, leg muscular power, and motor balance. They recommended conducting more scientific studies related to Tabata workouts to know its effectiveness in various sports activities.

Based on the foregoing results, the first hypothesis has been achieved, which states: "There are statistically significant differences between pre & post measurements of the experimental group in the physical variables understudy in favor of the post-measurement".

#### **Discussing the results of the second hypothesis:**

Which states, "There are statistically significant differences between pre & post measurements of the experimental group in the physiological variables and in the level of

technical performance of Thomas flair on pommel horse apparatus understudy in favor of the post measurement."

It is clear from Table No. (13) and Figure No. (5) that there are statistically significant differences at the level (0.05) between pre and post measurements of the experimental group in favor of the post-measurement in in the physiological and technical variables understudy, where the tabular ( $Z$ ) value was at the significance level of  $0.05 = (\pm 1.96)$ , while the calculated ( $Z$ ) values of the physiological and technical variables understudy ranged between  $(-2.809, -2.601)$ , and that these values are all less than  $(-1.96)$ , meaning that it is not limited between  $(\pm 1.96)$ , which It indicates that there are statistically significant differences between the means of the pre and post measurements of the experimental group at the level of significance (0.05) in the physiological and technical variables understudy in favor of the post-measurement.

As it is clear from Table No. (14) and Figure No. (6) that there are statistically significant differences between the pre and post measurements of the experimental group in favor of the post-measurement in the physiological and technical variables understudy, with percentage of improvement that ranged between (2.9%, 37.1%) , As the average  $vo_{2max}$  in the pre-measurement amounted to (45.27) ml / kg / min, and the development in the post-measurement reached (51.58) ml / kg / min, with percentage of improvement of (13.9%), while the average vital capacity in the pre-measurement amounted to (4,068) liters, and the development in the post-measurement reached (5,268) liters, with percentage of improvement of (29.5%), and the average anaerobic ability in the pre-measurement reached (932.57) kg.m/s, and the development in the post-measurement reached (1278.27) kg.m/s, with percentage of improvement of (37.1%), and the average rest pulse rate in the pre-measurement was (69.24) pulse /min, and the development in the post-measurement reached (67.26) ) pulse /min, with percentage of improvement of (2.9%), while the average degree of (Thomas Flair) skill in the pre-measurement reached (6.64 degrees) and became in the post-measurement (8.94 degrees), with percentage of improvement of (34.6%).

The researcher attributes these statistically significant differences between the means pre & post measurements and the percentage of improvement in the physiological variables understudy ( $vo_{2max}$ , vital capacity, anaerobic ability, rest pulse rate) to the application of Tabata protocol workouts in the main part of the training unit, and the exercise performance time was for (20) seconds. At a high intensity, followed by (10) seconds of positive rest, and the repetition of the exercise (8) sets, bringing the time for performing groups of each exercise to (4) minutes, resting after each exercise (1) minute in a session extending to (20) minutes. The duration of the training program was (12 weeks), with 3 training units per week.

This is also consistent with what was indicated by (Olson, M., 2014: 19) that Tabata protocol is a form of high-intensity interval training that performs in a short period of time, and is applied in many training programs in a number of diverse sports, and can be combined with other training methods, both aerobic and anaerobic ability can be developed by Tabata protocol workouts.

In light of the previous results and improvement rates, (Chapoton, B., 2015: 474) indicates that rationing the training load in the Tabata protocol depends on a high training intensity, and the load size is up to five groups, so that the performance is for a period of (20) seconds with high intensity, followed by (10) seconds of positive rest, for a period of time up to (4) minutes for one group, with a total Time (20-30) minutes of the training unit time

In this regard, (Foster, C., et al., 2015: 747) agrees with (Rebold, M., et al., 2013: 3419) that Tabata training is more effective and time-saving than traditional training methods,



and controlling the rest time to work time is easy to apply to develop both aerobic and anaerobic ability.

The previous results are consistent with those of (Shaheen, A. 2020: 210), On the positive effect of Tabata training on improving the physiological variables understudy ( $VO_2\max$ , vital capacity, anaerobic ability, rest pulse rate). she recommended conducting more studies to find out the effectiveness of Tabata training on various physiological variables.

The researcher also attributes the percentage of improvement in the level of technical performance of the skill (Thomas Flair) on the pommel horse apparatus understudy, to the positive effect of the Tabata workouts used as shown in Annex (6). Where the researcher took into account during the design of the workouts the diversity of tendencies of muscular work, and the employment of physical variables in the motor paths of the technical skill understudy, this is also consistent with (Abdel Salam, M. 2003: 98). The varied and interesting movements contained in the workouts led to increased enjoyment and not feeling bored, which clearly contributed to the development of the technical level of the research sample members. with a significant improvement rate of (34.6%).

The researcher adds the improvement in the level of technical performance of the skill (Thomas Flair) on the pommel horse apparatus understudy to the development of physical & physiological variables by carrying out various Tabata protocol workouts, which was reflected in the motor path of the technical performance variable understudy. In this regard, (Schultz, G. W. 2017: 84) indicates that physical abilities development workouts preferably suitable for the type of muscular work, in addition, the prevalent movements performed on devices and auxiliary tools have a positive effect on the level of technical performance.

The researcher believes that Tabata's various workouts, using tools and assistive devices continuously for 12 weeks, led to a significant improvement in the level of technical performance of the skill (Thomas Flair) on pommel horse apparatus understudy, and this is consistent with the consensus of the results of the studies of (Hussein, Sally. 2022: 247); (Gharib, F. 2021: 428) and (Solaiman, M. 2021: 291), that the technical performance has significantly improved due to the application of Tabata exercises, which made the players more control over the different parts of the body during the motor duty, which contributed significantly to the development of performance.

Based on the foregoing results, it is clear that the proposed Tabata protocol workouts have a positive effect on the level of technical performance of the skill (Thomas Flair) on the pommel horse apparatus understudy, through the development of physical & physiological variables and their use as requirements for skill performance.

Thus, the second hypothesis has been achieved, which states, " There are statistically significant differences between pre & post measurements of the experimental group in the physiological variables and in the level of technical performance of Thomas flair on pommel horse apparatus understudy in favor of the post measurement."

### **Conclusions and Recommendations:**

#### **- Conclusions:**

Based on what the research results showed, and in light of the research goal and hypotheses, the researcher reached the following conclusions:

- **The proposed Tabata protocol workouts have a positive effect on physical variables understudy, through:**
- The percentage of improvement in the physical variables understudy ranged between (11.7% and 52.1%).

- The average degrees of agility variable (Zigzag run test) in the pre-measurement reached (7.158 s), and it improved in the post-measurement and reached (5.858 s) with an improvement rate of (18.2%).
- The average score of the back muscles strength variable (Dynamometer) in the pre-measurement amounted to (122.42 kg), and it improved in the post-measurement and amounted to (136.72 kg) with an improvement rate of (11.7%).
- The average degrees of legs muscular power variable (Sargent's test - vertical jump) in the pre-measurement amounted to (49.48 cm) and an improvement in the post-measurement reached (75.28 cm), with an improvement rate of (52.1%).
- The average degrees of the dynamic balance variable (Modified Bass test) in the pre-measurement reached (71.83 degrees) and an improvement in the post-measurement reached (90.53 degrees), with an improvement rate of (26.0%).
- **The proposed Tabata protocol workouts have a positive effect on physiological & technical variables understudy, through:**
  - The percentage of improvement in physiological & technical variables understudy ranged between (2.9%, 37.1%).
  - The average scores of the vo<sub>2</sub>max variable (Cooper test) in the pre-measurement amounted to (45.27 ml / kg / min) and an improvement in the post-measurement reached (51.58 ml / kg / min) with an improvement rate of (13.9%).
  - The average degrees of the vital capacity variable using (Spirostik) in the pre-measurement amounted to (4,068 liters) and an improvement in the post-measurement amounted to (5,268 liters) with an improvement rate of (29.5%).
  - The average degree of the anaerobic ability variable, using (Sargent's test + equivalent), in the pre-measurement amounted to (932.57 kg.m / s) and an improvement in the post-measurement amounted to (1278.27 kg. m / s) with an improvement rate of (37.1%).
  - The average degree of the rest pulse rate variable using (Polar watch), in the pre-measurement, amounted to (69.24 pulse / min) and in the post-measurement it reached (67.26 pulse / min) with an improvement rate of (2.9%).
  - The average degree of the technical variable skill of Thomas Flair on pommel horse apparatus understudy, in the pre-measurement, amounted to (6.64 degrees) and improved in the post-measurement, which amounted to (8.94 degrees), with an improvement rate of (34.6%).
- **Recommendations:**

**In light of the results of the research results and the conclusions reached, the researcher recommends the following:**

  - Applying Tabata protocol workouts to develop the technical performance of Thomas Flair's skill on the pommel horse.
  - The combination of physical and technical workouts in proportion to the motor paths of the skills required to be developed with the aim of comprehensive preparation of the player, to reach the highest level of achievement.
  - Awareness of trainers about the importance and how to apply Tabata protocol workouts, in proportion to the requirements of technical performance on each gymnastics apparatus.
  - Applying Tabata protocol workouts in the technical preparation phase and the competition period, to make the most of mastering the technical routine on pommel horse apparatus.
  - Applying Tabata protocol workouts to different gymnastics apparatuses, and to other age stages.

**References:**

**Arabic References:**

- 1- **Abdel Baseer, Adel. (2019).** *Sports training and integration between theory and practice*, Cairo, Egypt, 7th ed., Al-Kitab Center for Publishing.
- 2- **Abdel Salam, Mohamed. (2003).** *Technical performance and educational steps of the pommel and parallel horse exercises*, Alexandria, Egypt. Dar Al-Maaref for Publishing.
- 3- **Abdel-Fattah, Abul-Ela Ahmed., Hassanein, Mohamed Sobhi. (2003 AD).** *Physiology and morphology of athlete and methods of measurement and evaluation*. 2nd ed., Cairo, Egypt: Dar Al-Fikr Al-Arabi.
- 4- **Al-Hadi, Ahmed. (2017).** *Methodological methods in teaching and training gymnastics*, Alexandria, Egypt. Dar-Almaaref for Publishing.
- 5- **Allawi, Mohamed. & Radwan, Mohamed. (2017).** *Motor Performance Tests*, 9th ed., Cairo, Egypt: Dar Al-Fikr Al-Arabi.
- 6- **Ghareeb, Fatima. (2021)** The effect of a program using TABATA workouts on the development of special fitness and the level of performance of some basic skills in technical exercises. *Scientific Journal of Physical Education and Sports Science*, 92(1), 428-454.
- 7- **Hassanein, Mohamed. S. (2015).** *Measurement and Evaluation in Physical Education and Sports*. The first part, 12ed ed., Cairo, Egypt: Dar Al-Fikr Al-Arabi.
- 8- **Hussein, Sally. (2022).** The effect of a Tabata-style training program on the level of physical performance and rope jumping for female students of the Faculty of Physical Education. *Scientific Journal of Physical Education and Sports Science*, 94(2), 247-264.
- 9- **Khalil, Mohamed. (2020).** *Tests and Measurements in Physical Education*. Unpublished notes, Faculty of Physical Education, Mansoura University.
- 10- **Nabil, Walid. (2005).** *The relative importance of the elements of special fitness as determinants of designing a training program on some gymnastics equipment*, published research, Faculty of Physical Education, Helwan University.
- 11- **Radwan, Mohamed Nasr El-Din., Masoud, Khaled Hamdan. (2013).** *Physiological measurements in the sports field*, Cairo, Egypt: Book Center for Publishing.
- 12- **Shaheen, Amira. (2020).** The effect of using Tabata training on the level of physiological efficiency and the level of skill performance in tennis. *Scientific Journal of Physical Education and Sports Science*, 88 (2), 210-226.
- 13- **Shehata, Mohamed. (2019).** *Contemporary Gymnastics Training*, Cairo, Egypt: Dar Al-Fikr Al-Arabi.
- 14- **Solaiman, Mona. (2021).** The effect of Tabata combat ropes training on some physical variables and the accuracy of the forehand performance of a table tennis junior. *The Scientific Journal of Sports Sciences*, 5(3), 291-310.
- 15- **Youssef, Ahmed Esmat; Khatlab, M. & Ghoneim, J. (2021).** The relative importance of physical characteristics on the pommel horse apparatus as an indicator for guiding preparation programmes. *Scientific Journal of Physical Education and Sports Science*, 93(4), 1-15.

**Foreign References:**

- 16- **Atilgan, O. E. (2013).** Effects of trampoline training on jump, leg strength, static and dynamic balance of boys. *Science of gymnastics journal*, 5(2), 15-25.

- 17- **Baumgartner, T. A., & Jackson, S.J. (2012).** *Measurement for evaluation and exercise science*, 7th ed. Brown and Bench mark publishers.
- 18- **Chapoton, Brandon., (2015).** Sprint Interval Cycling Training the Effect of Tabata Protocol on Collegiate Level Distance Running, *J Sports Sci Med*, 14(4).
- 19- **Emberts, Talisa., Porcari, J., Dobers-Tein, S., Steffen, J., & Foster, C. (2013).** Exercise intensity and energy expenditure of a Tabata workout. *Journal of sports science & medicine*, 12(3), 612.
- 20- **Fortner, Howard. A., Salgado, J. M., Holmstrup, A. M., & Holmstrup, M. E. (2014).** Cardiovascular and Metabolic Demands of the Kettlebell Swing using Tabata Interval versus a Traditional Resistance Protocol. *International journal of exercise science*, 7(3), 179–185.
- 21- **Foster, Carl., Farland, C. V., Guidotti, F., Harbin, M., Roberts, B., Schuette, J., Tuuri, A., Doberstein, S. T., & Porcari, J. P. (2015).** The Effects of High Intensity Interval Training Vs Steady State Training on Aerobic and Anaerobic Capacity. *Journal of sports science & medicine*, 14(4), 747–755.
- 22- **International Gymnastics Federation. (2020)** *Code of points for men's artistic gymnastics competition at world championships*, Olympic Games, Regional and intercontinental Competitions events with international participants.
- 23- **McRae, Gill., Payne, A., Zelt, J. G., Scribbans, T. D., Jung, M. E., Little, J. P., & Gurd, B. J. (2012).** Extremely low volume, whole-body aerobic–resistance training improves aerobic fitness and muscular endurance in females. *Applied Physiology, Nutrition, and Metabolism*, 37(6), 1124-1131.
- 24- **Miller, Laura. J., D'Acquisto, L. J., D'Acquisto, D. M., Roemer, K., & Fisher, M. G. (2015).** Cardiorespiratory responses to a 20-minutes shallow water Tabata-style workout. *International Journal of Aquatic Research and Education*, 9(3), 292-307.
- 25- **Olson, Michele. (2014).** TABATA: It's a HIIT!, *ACSM'S Health & Fitness Journal*, 18(5), 17-42
- 26- **Rebold, Michael. J., Kobak, M. S., & Otterstetter, R. (2013).** The influence of a Tabata interval training program using an aquatic underwater treadmill on various performance variables. *The Journal of Strength & Conditioning Research*, 27(12), 3419-3425.
- 27- **Schultz, G. W. (2017).** *Applied Kinesiology: The Scientific Study of Human Performance*. McGraw-Hill.
- 28- **Tabata, I., Irisawa, K., Kouzaki, Motoki, Nishimura, K., Ogita, Futoshi, & Miyachi, M. (1997).** Metabolic profile of high intensity intermittent exercises. *Medicine and science in sports and exercise*, 29(3), 390-395
- 29- **Tabata, Izumi., Nishimura, K., Kouzaki, M., Hirai, Y., Ogita, F., Miyachi, M., & Yamamoto, K. (1996).** Effects of Moderate-Intensity Endurance and High-Intensity Intermittent Training on Anaerobic Capacity and VO<sub>2</sub>max. *Medicine and science in sports and exercise*, 28, 1327-1330.